NEW YORK SEATTLE

MOTORSHIP

Devoted to Commercial and Naval Motor Craft

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JUNE, 1919
Vol. 4 No. 6

NOTEWORTHY ECONOMICAL MERCHANT SHIPS—No. 30

"Sabara," ex "Monte Penedo," a two-cycle Diesel-engined motorship built in 1912 for the Hamburg-South America Line, but seized by the Brazilian Government two years ago. She recently visited New York after a long voyage from Rio de Janeiro, via Africa, France, and Spain. When she was taken over by Brazil, no experienced oil-engineers were available, but the authorities learned that a young naval student had been reading books on Diesel engines and ordered him to take the ship to sea. This man, Abilio Sergio de Miranda, is still chief-engineer. The "Sabara" is propelled by two four-cylinder Sulzer-Diesel engines of 850 b.h.p. at 150 R.P.M. Length of ship, 350 ft. Breadth, 50 ft. Tonnage, 6,500 tons D.W.C. Speed, 10½ knots. Her engines occupy much less space than the average motorship or steamship's machinery.

Contents copyrighted 1919

MOTORSHIP

Trade Mark, Registered

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PUBLISHED MONTHLY IN THE INTERESTS OF COMMERCIAL AND NAVAL MOTOR VESSELS AND FOR RECORDING PROGRESS OF THE MARINE INTERNAL-COMBUSTION-ENGINE

Published by MILLER FREEMAN & COMPANY

President—MILLER FREEMAN

Advertising Manager—J. CHARLES RUIF

Manager—RUSSELL PALMER

Editor—THOS. ORCHARD LISLE
A. M. S. Naval Engineers. A. M. I. Marine Engineers

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The oil-engined motorship has arrived! It is such a pronounced economy that it was bound to come. Nothing could stop it! And all obstacles have been removed as fast as they arose. The law of progress has seen to that. Very strong prejudices stood in the way of steam. But, one after another they were swept aside and steam reigned triumphant for a century. Steam now has had its day! Its zenith has passed, and gradually but surely it is being superseded by the economical internal-combustion power. America, the most important oil-producing country, is to be the greatest motorship-owning nation. Let us all co-operate and assist to make that day soon.

June, 1919 Vol. 4 No. 6

EDITORIAL

OUR SPECIAL SCHNEIDER WAR AND PEACE COMMEMORATIVE SUPPLEMENT

EVERY subscriber to "Motorship" receives with his copy of the June issue the most remarkable art-supplement ever presented by a technical publication to its readers. This supplement forms a worthy acknowledgment to the magnificent war and peace achievements of a great French engineering and shipbuilding company, who in size and importance stand second to none in the world.

During the war the censorship drew a curtain in front of Messrs. Schneider & Co.'s tremendous engineering efforts made not only on behalf of France, but for the United States and other Allies. America is deeply indebted to the splendid assistance given by Monsieur Eugéne Schneider and his great organization to many of our large engineering-concerns and steel plants and to our army in France. Without the great quantities of guns supplied by Messrs. Schneider, our soldiers could not have gone to the front lines until nearly a year later, and the war probably would still be on. Yet, curiously enough, no one in this country has yet thought fit to take advantage of the many years marine and stationary Diesel-engine experiences offered by this company.

Perhaps some of our own engineering concerns can benefit not a little from the very progressive spirit shown by this renowned French establishment. We, on our part, feel highly honored that Messrs. Schneider & Co. should select "Motorship" out of all the publications in America and Europe for the purpose of revealing to the world what they have done to assist in winning the war and what they are now doing for the re-organization of commercial industries and commerce.

An idea of the enormous size of the Schneider organization may be gathered from the fact that their twelve principal plants cover 17,300 acres and have 2,500 telephone stations. This, apart from nine subsidiary companies, also large works in Russia, and financial interest in other concerns.

It is understood that Monsieur Eugéne Schneider may shortly visit America, and we can assure him a true, cordial American welcome.

As it is not practical to place this supplement on the news-stands of this country, it is only being mailed to our subscribers and to a specially selected list of interested business men and Government officials. But, for firms who purchase "Motorship" through their newsdealers, we are reserving a limited number of copies which will be mailed gratis upon application provided they fill out the coupon on page 29 of this issue.

CONVERSION OF AMERICAN STEAMSHIPS TO MOTOR POWER, AND THE IMPORTATION OF EUROPEAN DIESEL-ENGINES

WHEN the quantity of freight to be carried begins to be less than the capacities of ships in service, many shipowners not only will be seriously considering converting their existing steam-vessels to Diesel-motor power, but in many cases will actually be forced to do so by necessity, or else lay-up their craft for months at a time. Probably commencing with the end of the present year there will be regular periods of rush and slack in the shipping industry, and during the periods of depression the only ships that will be carrying full cargoes will be motorships, which, by reason of their great economy, will be able to carry at greatly reduced rates without loss, and so always will be certain of ample business, whether they are domestic or foreign owned.

To an extent this will affect the domestic oil-engine industry, particularly inland manufacturers, because it makes it important for builders to endeavor to reduce manufacturing costs of Diesel motors. Under existing laws, Europeans and Japanese can import marine internal-combustion engines in bond for the purpose of installation as propelling power in existing American-built ships, a customs duty of 20 per cent being payable. But, as soon as the engines are installed in such vessels a rebate of 99 per cent of the duty is allowed. This means that, given an equal selling-price at the builder's works, Diesel-engines could be imported at the same or less cost, under normal ocean rates, than they can be delivered to the seaboard from Chicago or similar points inland. If, of course, foreign companies produce oil-engines more cheaply than they can in this country, it may mean severe competition. At present, owing to the high cost of material in Europe, American Diesel-engines are slightly less in cost, so the advantage now rests with us. But, Germany already has started to pour steel and iron into non-allied countries and this may effect a reduction in the prices of engines built abroad. Therefore, we must prepare to meet the situation.

FEDERAL MOTORSHIP-ENGINE CANCELLATIONS

FULL publicity has been given to Mr. Chas. Piez's cable to President Wilson in which he protested against Chairman Hurley's wholesale cancellation of shipbuilding contracts at the time when he—Mr. Piez—retired from his office as Vice-President of the U. S. Shipping Board Emergency Fleet Corporation. We regret to say that at the same time the Shipping Board cancelled all but 6 of the 36 Diesel engines left out of the original 72 ordered, although the materials for 50% of the total number of engines were

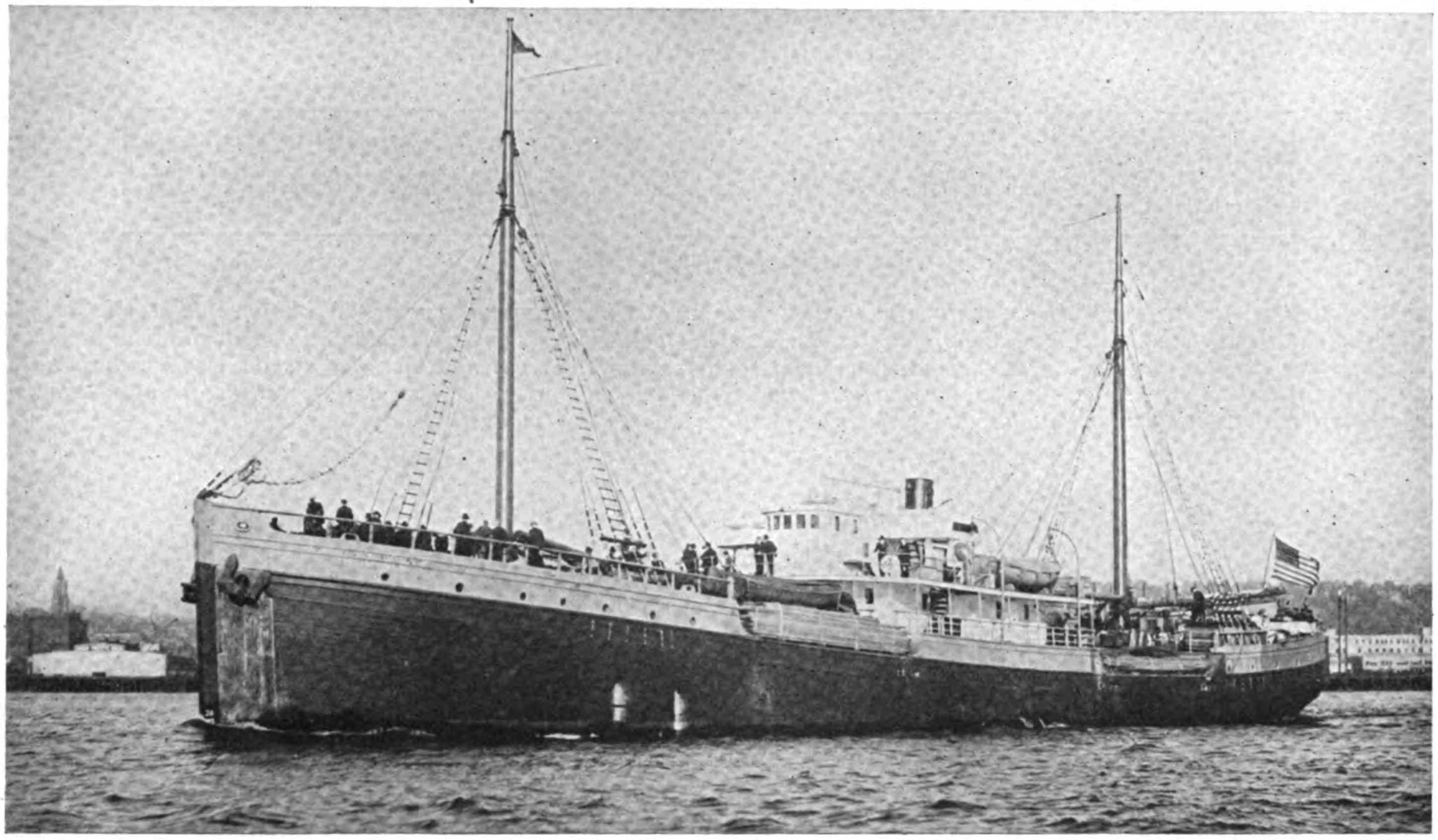
in the builder's work. So it would have been much more economical to have finished the engines and offered them for sale, even had the Shipping Board no hulls for them. Or they could have been used with advantage in some of the wooden hulls.

In cancelling this order, Mr. Hurley, whom we believed was a strong motorship advocate, has shown singular lack of judgment, and at the same time has given a tremendous blow to the domestic oil-engine industry. We trust Congress will not let the matter stand, and as Senator Wesley L. Jones, a far-sighted and progressive westerner, now heads the Senate Committee on Commerce, we can feel assured that a complete investigation will be made, and the cancelled contracts re-instated but possibly changed to higher-powered Diesel engines.

OUR EDITOR OFF TO EUROPE

DURING the middle of this month our Editor, Mr. T. Orchard Lisle, intends leaving this country on a tour of the British and European shipbuilding yards and marine oil-engine works. His itinerary includes France, England, Scotland, Switzerland, Italy, Norway, Sweden, Holland and Denmark.

Any firms in these countries who desire to have our Editor visit them, should address letters to him at "Cranmere," Queens Rd., St. Thomas, Exeter, Devonshire, England. Should there be any little missions that our Editor can undertake on the behalf of American companies in this industry, in the way of placing European manufacturers and builders in communication with them for the purpose of establishing business relations, will they kindly communicate the same before he sails?



The successful American built and engined Diesel wooden motorship "Libby Maine"

More Good Work by the "Libby Maine"

This American-Built and Engined Wooden Motorship Makes Another Splendid Voyage

ONE of the most remarkable and significant performances that has been made by a wooden motorship in deep-sea service is that of the cargo vessel "Libby Maine," which arrived in Seattle on Sunday, April 27, 1919, after a voyage across the Pacific, in which she covered a total of 14,170 nautical miles. It is claimed by the navigators, and so far as we have been able to determine, is an actual fact, that this vessel, since going into commission, has made more actual running time than any other motor-vessel built in America. This is especially interesting in view of the fact that she was built on the Pacific Coast, and is powered with Diesel engines which are also a product of the Pacific Coast.

The "Libby Maine," it may be remembered, was built in Portland, Oregon, by the Standifer Construction Company, and was fully described in our issue of August, 1918. She is a full-powered motorship, equipped with two 320 b.h.p. Dow-Willans Diesel engines, constructed by the Dow Pump and Diesel Engine Company of Alameda, California.

Prior to sailing on this trip across the Pacific, she made two successful coastwise voyages under extremely successful auspices. On her most recent voyage, she left Seattle December 27, 1918, for Honolulu, Manila, Hongkong and return. The record of this last voyage, showing the distance traveled, the average speed and the fuel-consumption, is shown in the following table:

Total number of knots traveled	14,170
Seattle to Honolulu, (distance)	2,458 nautical miles
Seattle to Honolulu, total fuel-consumption	255 barrels
Seattle to Honolulu, time	15 days, 2 hours, 24 minutes
Seattle to Honolulu, average speed	6.78 knots
Seattle to Honolulu, average daily fuel-consumption	16.88 barrels
Honolulu to Manila, (distance)	4,966 nautical miles
Honolulu to Manila, total fuel-consumption	468 barrels
Honolulu to Manila, time	28 days, 16 hours, 44 minutes
Honolulu to Manila, average speed	7.21 knots
Honolulu to Manila, average daily fuel-consumption	16.3 barrels
Manila to Kongkong, (distance)	658 nautical miles
Manila to Hongkong, total fuel consumption	63 barrels
Manila to Hongkong, time	3 days, 15 hours, 45 minutes
Manila to Hongkong, average speed	7.22 knots
Manila to Hongkong, average daily fuel-consumption	17.23 barrels
Hongkong to Seattle, (distance)	6,088 nautical miles
Hongkong to Seattle, daily fuel-consumption	17.25 barrels
Hongkong to Seattle, time	35 days, 20 hours, 1 minute

The details of the voyage made by this vessel are worth noting. Leaving Seattle, she had a general cargo consigned to Manila. She stopped at Honolulu for fuel-oil, and after taking on fuel, distillate and fresh water, she sailed for Manila after a delay of twenty-four hours, due to the formality of securing a fuel permit by cable from San Francisco.

The boat left Honolulu January 14th, and ran steadily with good weather and perfect working conditions, arriving at Manila February 13th.

Leaving Manila on March 14th, after an uneventful trip in which there were absolutely no stops, the "Libby Maine" arrived at Hongkong March 18th. After completing her return cargo here, consisting of Philippine hardwood, copra meal and firecrackers, the ship left Hongkong March 23rd. The boat arrived back at Port Townsend on April 27th, stopping there for 1 hour and 26 minutes, after which she proceeded to Seattle, arriving there at 7:10 P. M. on the evening of April 27th.

Chief-Engineer A. Fabel was extremely well pleased with the performance of the engines, and was unstinted in his praise of their reliability. "I am just as confident," he said, "of the Dow Diesel engines, as I am of any of the steam engines I have ever had under my care. The motors have proven themselves even beyond my expectations, and on the entire trip we had absolutely no trouble."

Chief-Engineer Fabel has made a very careful study of the Diesel engine, having undertaken the study at the suggestion of Mr. Bernard Mills, of the American Hawaiian Steamship Company of New York, who also has made careful investigations. His first experience with this type of motor was with these engines of the "Libby Maine." Going into the shops of the builders during the test trial, he became thoroughly familiar with their operations. Later he went out from the shops with the motors and helped during their installation. On her maiden voyage, he was given the post of First-Assistant-Engineer. Upon her return he was promoted to the position of Chief-Engineer.

The following table gives a summary of the voyages the "Libby Maine" has made since first being launched, together with information concerning the mileage covered, fuel consumed, etc., the variation being due to head winds and seas and other weather conditions which affect the running time of any vessel:

MOTORSHIP "LIBBY MAINE" ABSTRACTS OF LOGS

Fuel Tank Capacity, 1,187 Bbls. Average Cruising Speed, 240 R.P.M., Propeller Speed 96 R.P.M.

The personnel of the vessel on her last voyage was as follows:

Master....................Captain E. M. J. Herre
Chief-Engineer..........................A. Fabel
First Assistant Engineer............W. W. Leloh
Second Assistant Engineer............E. Whalley

The "Libby Maine" loaded immediately for another voyage, this time taking on supplies for the Bristol Bay Canneries of the owners, Libby, McNeil and Libby, of Chicago, of which firm Mr. Philip Larman is the General Manager.

VOYAGES	Miles	Time Hours	Aver. Knots	FUEL OIL USED Total No. Barrels	Gal. per Nautical Mile	Barrels per Day	Knots per Bbl.
Seattle—Alaska	2067	309.5	6.6	209.6	4.2	17.5	9.9
Alaska—Seattle	2067	291.5	6.	244.4	4.9	17.5	8.5
Seattle—Honolulu	2400	354¼	6.88	259.5	4.46	17.58	9.2
Honolulu—San Francisco	2091	357.3	5.77	305.	6.12	20.3	6.86
San Francisco—Seattle	828	141.4	6.	103.4	5.26	17.47	8.
Seattle—Manila via Honolulu	7424	1051	7.1	750.8	4.2	17.1	9.9
Seattle—Honolulu	2458	362.3	6.	255.	4.3	16.88	9.8
Honolulu—Manila	4966	688.7	7.21	468.	4.	16.3	10.7
Manila—Hongkong	658	87.7	7.72	63.	4.	17.23	10.5
Hongkong—Scattle	6088	860.3	7.08	663.4	4.5	18.4	9.2

Consolidated Shipbuilding Corporation

New York City Shipbuilding Concern Changes Name

THE Gas Engine & Power Company and Charles L. Seabury & Company, Consolidated, of Morris Heights, is now known as the "Consolidated Shipbuilding Corporation." This well-known company has operated for over thirty-five years and has built more than 3,000 craft. It won its original reputation as builders of naphtha launches and later as builders of the steam-yachts and motorboats. It has for many years devoted its facilities to a considerable extent in building Government vessels. It has built and delivered during the war, mine-sweepers, flying-boat hulls, marine internal-combustion engines, water-tube boilers, and converted a great many yachts and motorboats for war service.

The officers of the Consolidated Company, who have been connected with the industry for many years are:

President ....John J. Amory
Vice-President................William J. Parslow
Secretary & General Manager..Bruce Scrimgeour
Treasurer ....Clement C. Amory

In the original incorporation, the name adopted was the Gas Engine & Power Company, and was founded in 1885 by Clement Gould and F. W. Ofeldt, to build launches powered by naphtha engines, the invention of F. W. Ofeldt and derived their power through the expansion of naphtha-gas on pistons in the same general principle as a steam-engine.

The original shop at 131st Street and Brook Avenue, on the Harlem River, was soon too small, and in 1887 the company moved to a site purchased at Morris Dock, New York City, now known as Morris Heights, where the present plant is located. Among those connected with this company at the start of activities was Charles L. Seabury, acting in the capacity of Superintendent, and William J. Parslow, as Office Manager.

In the fall of 1887, Charles L. Seabury was elected Vice-President, and John J. Amory became associated with the organization in the capacity of Secretary and Treasurer. Two years later, Charles L. Seabury left the company, and with William J. Parslow established a yacht-building company at Nyack on the Hudson, known as Charles L. Seabury & Company.

The Gas Engine & Power were building practically the only power launches in the world. Many wealthy men took to this type of boating, and consequently naphtha launches were produced in large numbers. In 1894, Clement Gould, President of the company, died, and John J. Amory was elected to the office of President.

In 1896, purchase was made of the stock of the Charles L. Seabury Company, at Nyack, and that company moved to Morris Heights to form the consolidation, known as the Gas Engine & Power Company and Charles L. Seabury & Company, Consolidated. Additional property was purchased, buildings erected and additional machinery, tools and equipment installed. Charles L. Seabury was elected First Vice-President of the new company, and a few years later, William J. Parslow was elected Third Vice-President. The company continued the construction of launches and yachts and their propelling machinery and turned out the finest craft built in this country.

In 1897, they undertook a contract to design, construct and power one of the first class of torpedo-boat destroyers for the United States Navy, the "Bailey." This boat won world-wide renown, holding for several years the distinction of being the fastest boat in the Navy. Two other torpedo-boats were built a little later, known as the "Stewart" and "Wilkes."

Subsequently, the company took an active part in Government work. In 1904, they built the gun boats "Dubuque" and "Paducah."

During these years, while the popularity of the naptha launches continued, the gasoline engine introduced in automobiles began to find its adaption for marine use. In 1903, the company first took up with success the building of a gasoline marine-engine, which was known as the "Speedway." The power found available in the gasoline engine soon caused the call for speed on the water. John J. Amory and Charles L. Seabury were foremost in the building of the first speed boats, which John J. Amory termed "Auto boats." This class of boat was immediately popular and continued so for many years. The name gradually died out, and has given way to the more common term of "motor boat.'

In 1914, Charles L. Seabury resigned as an officer of the company, and a few years later left the organization.

The outbreak of the war found the company following its usual line of business. It immediately offered its entire resources to the United States Navy, and converted many yachts to patrol vessels.

The company was then called upon to build five 1,000-ton steel ocean-going mine sweepers. This task was a large one and necessitated the addition of heavy tools and machinery and the installation of an entire new steel ship construction equipment. The next contract was one which engaged the small boat-building department for 175 flying-boat hulls. Contracts for nine tugs were also taken from the U. S. Shipping Board Emergency Fleet Corporation. When the armistice was signed the company had delivered three of the steel vessels, seventy-five flying-boat hulls and had converted for service in the Sectional Patrol of the United States Navy, some seventy-five yachts and motor boats, besides completing considerable repair work on Navy vessels.

The Consolidated Shipbuilding Corporation is now busily resuming its former line of business. The present manufacturing organization is headed by men who have been prominent in the industry and connected with this company for many years. It is headed by Bruce Scrimgeour as General-Manager; Joseph S. Potter as Superintendent; Albert Christen as Mechanical Superintendent; H. W. Patterson as Chief Constructor; H. E. Fromme as Chief-Engineer; J. E. Lowery as head Boat-Builder, and J. M. Forhenach as Assistant-Superintendent.

At the present time the company has the most completely equipped yard in the country for construction of the smaller size of vessels. It is capable of producing all type of craft, hull, machinery and equipment up to fifteen hundred tons. It is also doing considerable overhauling and general ship repairs.

In the beginning of 1919, the company had the following abbreviations:

Gas Engine & Power Company, Charles L. Seabury & Company, Seabury's, Speedway Shipyard, Seabury Shipyard, Morris Heights Shipyard, Speedway Company.

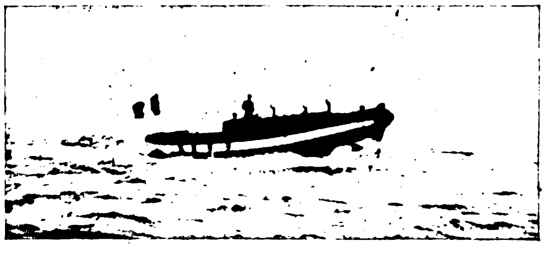
To avoid these many abbreviations and to shorten the corporation title, it was decided to change the entire name of the company. The name "Consolidated Shipbuilding Corporation" denotes the true condition, that is, a firm union of two companies to form one system. The trade name "Speedway" will still be retained to cover their gasoline marine-engines.

SOUTH AMERICAN MOTORSHIPS

We understand that the Lloyd Nacional Shipping Co. of Rio de Janeiro are about to commence construction of wooden motor ships. Heavy-oil engines will be installed. We suggest that American oil-engine builders send catalogues.

DIESEL, SURFACE-IGNITION AND DISTILLATE ENGINES REQUIRED

Mr. B. Pelny, Paijan, Peru, is desirous of receiving quotations on marine motors from 120 to 200 H. P. The engines for which he desires quotations are of the Diesel, surface-ignition and



distillate types. He has in service a tug which we illustrate, fitted with a 40 h.p. Standard motor, which he says has given splendid results.

An American Diesel Engine

Complete Details of the Latest Model Winton Heavy-Oil Marine Engine

ONLY after any piece of mechanism has proved itself by giving satisfactory service when used in quantities, can a seal of approval be placed upon it—and perhaps we should add—and provided the service has been performed in the hands of those not specially trained to handle the same. Then the significance of the test is much greater and renders the approval unquestionable. Undoubtably this seal has been placed upon the Winton Diesel type of heavy-oil marine engines, by such shipowners who have installed them in their vessels.

Alexander Winton of Cleveland the veteran automobile designer is the man responsible for the design and production of this engine. It may be in keeping with this article to say something about Mr. Winton himself. Mr. Winton was born in Scotland some fifty years ago,—eventually he chose for his future the engineering field in the shipyards of the Clyde and there learned his trade, leaving Scotland to make a few trips at sea to further complete this education. He finally settled in New York City and there began experimenting, not as one would suppose, in the marine field, but in quite a different line—he began experimenting in bicycles and finally built one which he put on the market in the city of Cleveland, under the name of the Winton Bicycle Company.

Hardly had this been proved a commercial success when the self-propelled vehicle drew his attention and about 22 years ago he started building what proved to be the first really saleable self-propelled horseless vehicle built in America. But it does not seem at all strange that he should after almost 20 years of automobile building, turn back to the marine engine and enter this field by building marine gasoline engines, which, without question, proved to be the most successful. Five years ago he undertook the designing and building of what he believed to be the future power plant of the merchant marine—the Diesel oil-engine.

Altho, with the exception of his own engine, Mr. Winton had never actually seen a Diesel engine until quite recently, he believed his prime mover to be the logical successor of the steam-engine for all merchant marine service. Like the progressive manufacturer, he also believes that there are principles of design never before used in marine engines which are adherently better, not only for the manufacturer but for the user and for the apparatus itself, so he embodied this theory in the Winton Diesel engine. He maintains that the results obtained to date prove his contentions are correct.

The first Diesel-engine designed and built by Mr. Winton at the Winton Engine Works was the type which at that time seemed to fill the greatest demand. This was for a power plant for auxiliary-schooners, or full-powered vessels having a carrying capacity up to 4,500 tons. This meant an engine of compact design and of moderate weight and one that could endure this work for a long period of time. This type also lends itself to production in a large manufacturing plant. In three years of service at sea both in auxiliary-schooners and full-powered motorships, of this size they have rendered excellent service.

One of a number of examples of Winton-equipped ships now in service the "James Timpson," which lately completed a 14,500 mile voyage, equipped with two six-cylinder Winton Diesel engines, operating at comparatively high speed and driving the propellers through reduction-gears and which we dealt with in a recent issue. But, this is only one of a half-dozen or dozen similiar cases.

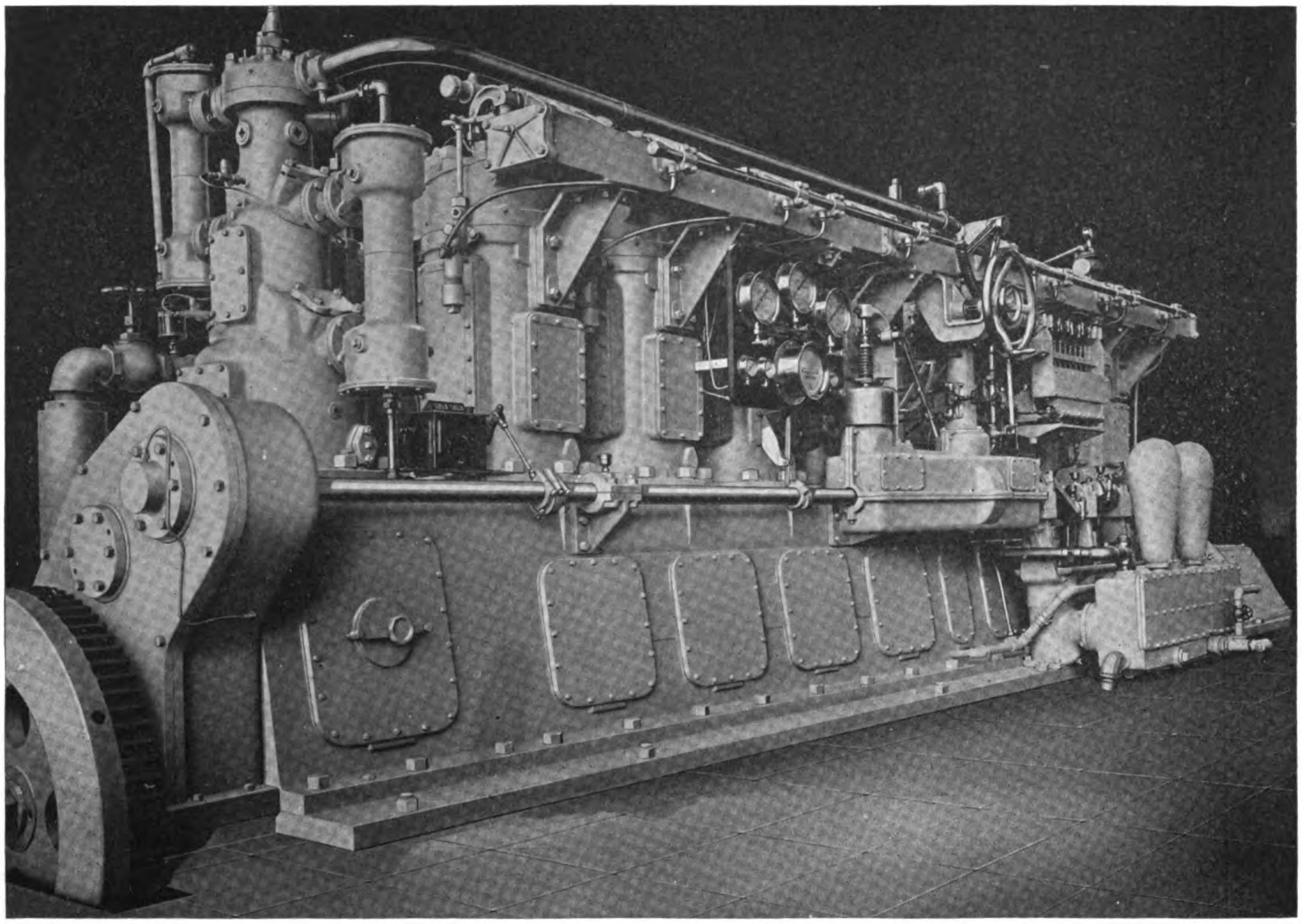
There is naturally at this time wide spread public interest in the development of shipping to sail under the American flag. There is not, however equally widespread knowledge of the economies to be effected by the use of the heavy-oil Diesel engine in place of the orthodox steam plant, altho "Motorship" has done much to make these economies known. These economies are two-fold; first, largely increased carrying capacity of a given sized ship, due to the much smaller space requirements of the power plant; and second, the greatly decreased operating cost. These we need not detail here, as they have constantly been outlined in our columns.

The majority of the Diesel engines built in the past for motorships have either been constructed abroad, or built in this country under foreign patents. These have usually been of the open crankcase, crosshead type, following accepted marine practice in the case of steam engines. Among the few strictly all-American designs, the Winton engine stands out because of its departures from the conventional accepted forms. That these departures have been in no way detrimental—at lease up to the sizes in which they have been built—is supported by the records established during the past two years on many ships. Furthermore, they have permitted the construction of very light, compact units, running at higher speeds than have yet been generally accepted, and with sufficient reserve power for emergencies.

Of course, there are many differences of opinion regarding the best forms of design for merchant ship installation, and doubtless many engineers will not agree with the theories put forward in this article by the Winton designers. Nevertheless, we gladly give space to their contentions and in the same way our columns are open to engineers who may desire to challenge the statements of the Winton Co., provided they are legitimately supported by experiences.

Winton engines have been produced in large numbers in the following three sizes:

Six-cylinder, 11 x 14", known as Model W 35



A Six-cylinder Winton marine Diesel engine

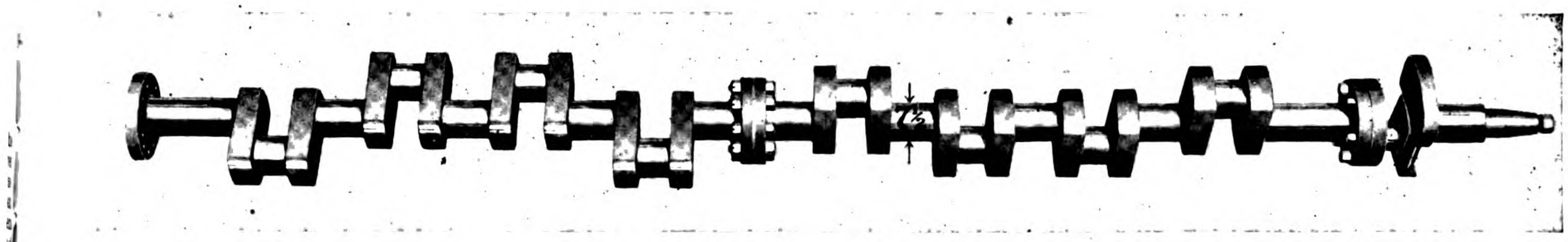
Six-cylinder, 13 x 18", known as Model W 24 A

Eight-cylinder, 13 x 18", known as Model W 40

In designing his engines, Mr. Winton departed greatly from steam-engine practice, and applied the proven principles of standard marine gasoline engine practice wherever they logically could be used. The outstanding features of his engine are; the use of an enclosed crankcase, trunk-pistons—instead of the usual short-pistons with cross-head arrangement—and crank-shaft bolted up to its bearings, which are suspended from the upper half of the crank-case.

This method of mounting the crank-shaft, which is practically universal practice in gasoline-engine design, has two very important claims. It is well understood that practically all the wear which takes place in main bearings is in the lower halves, as the thrust is in the direction in the power strokes. As wear takes place, the crank-shaft drops slightly from its original position. If the wear is unequal in the various parts, the result is that the shaft is sprung more or less out of line, straining the shaft and reducing the effective output of the engine.

Where the lower halves of the bearings are fixed

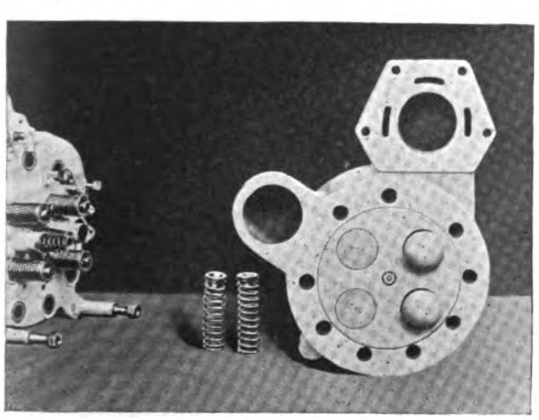


Three-piece crank-shaft of Winton Diesel motor

and the upper halves are bolted down to them, the Winton designers claim that it is very easy in taking up loose bearings to spring the shaft seriously out of line. Further the Winton Company says that it is almost out of the question to get at the lower halves; and, that, it is very difficult to determine when the bearings are exactly in line, also, if looseness develops where the shaft is bolted up to the fixed upper halves of its bearings, taking up the looseness simply restores the shaft to its original alignment. With these particular contentions we do not necessarily agree or dispute but publish them in order to afford other builders an opportunity to reply in our columns as mentioned above.

Their Second claim for this mounting is that taking-up wear in the bearings brings the pistons up to their original position again so that the compression remains unchanged. Where the shaft is bolted-down to its bearings the wear which inevitably takes place permanently reduces the compression. Naturally, the engine will operate most satisfactorily under the conditions for which it was designed and built.

In Diesel engines there is no explosion in the power cylinders as is in the ordinary constant-volume type of small internal-combustion engine, but the fuel is really burned, giving very high, steady pressure. The fuel is forced into the



Cylinder head showing inlet and exhaust valves

cylinder, against the compression, by air at 850-950 pounds pressure. This not only carries the fuel into the cylinder but breaks it up into very fine particles, so that the combustion is complete and consequently smokeless. The high-pressure air for this purpose is obtained from the air-compressor at the forward end of the engine. In the Winton design the latter is of the three-stage type and is of very interesting design. The piston is of the trunk type and is operated by a connecting rod, which, is a duplicate of the connecting rods in the power cylinders, and a single throw counter-weighted crank-shaft which is bolted to the front end of the main crank-shaft. The throw of this single crank is somewhat less than that of the main crank. Following each stage of the compression the air is water cooled, so that on delivery it is at normal temperature.

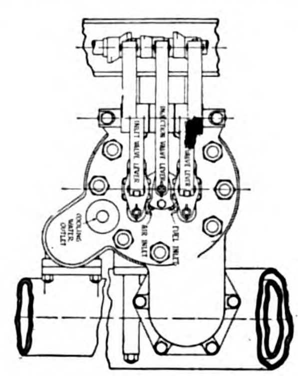
The capacity of the air-compressor is considerably in excess of that required for the injection of the fuel into the cylinder, providing for the initial charging and the maintenance of pressure in the starting-air storage tanks.

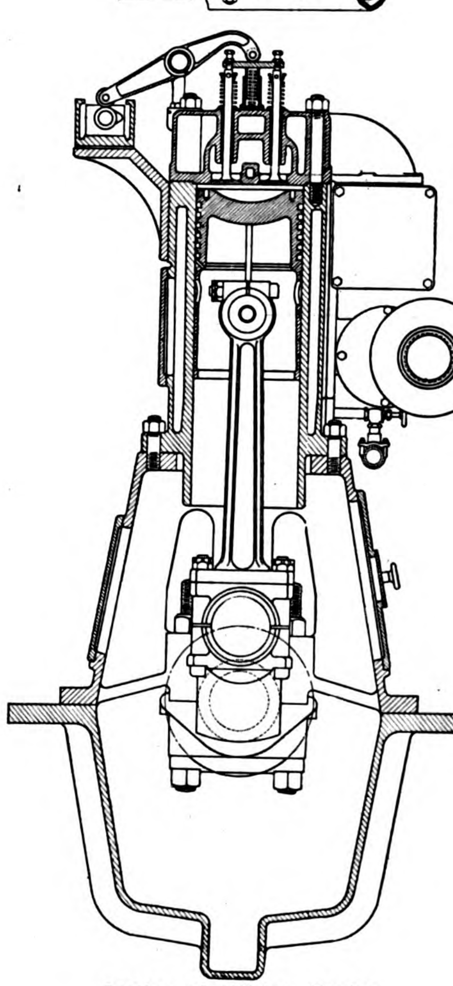
There are two sets of these air bottles; one carrying air at about 600 pounds pressure per square inch, which is admitted to the cylinders in turn to force the piston down and thus starting the engine rotating. The second set of air bottles carries air at 1,000 pounds pressure per square inch, which is used to inject the fuel into the cylinders.

The crank-case is of grey iron, and cast in one piece, of skeleton construction; that is, the sides have large openings opposite each throw of the crank-shaft, each of which is provided with a cover plate affording easy access to all parts of the interior. A main-bearing for the crank-shaft is provided on each side of each throw of the crank-shaft, each bearing being supported by heavy ribs, so that the crank-case is very rigid. The lower part of the crank-case is enclosed by a trough-shaped casting which extends from the timing gear in the front to the rear of the thrust bearing at the back end of the engine. The crank-shaft and connecting-rods are thus fully enclosed, so that there is no possibility of oil being splashed outside of the engine. The bearing-caps are each bolted up to the crankcase by four large studs and nuts. The bearings themselves are heavy shells, lined with high quality babbitt-metal. Each bearing has an individual oil-lead from a header running the full length of the crankcase. This header is connected to a two-cylinder reciprocating oil pump which maintains constant oil pressure on the bearings.

Because of the considerable weights and sizes of the forgings involved, the crank-shaft is made in three pieces; two sections each having three or four throws for the power cylinders, and a single throw section for the air-compressor. These sections are flanged and bolted solidly togther before being assembled into the crank case. From each main-bearing of the shaft, a hole is drilled thru the adjacent web to the crank-pin. These holes register with grooves in the main and connecting-rod bearings, so that the connecting-rod lower bearings are also lubricated under pressure directly from the pump.

The connecting rods are I-section forgings, split at the upper end and clamped around the piston

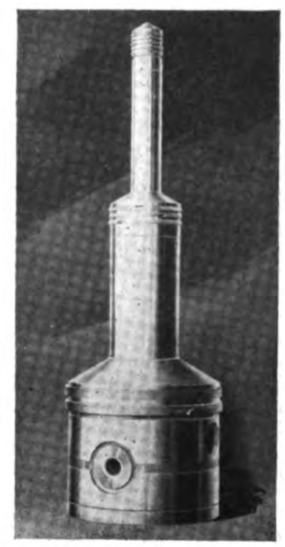




Section of Winton Engine

pins, and formed into a T-head at the lower end, to which two half-boxes and a supporting cap are bolted. Each rod has an oil-tube connecting with the groove in the upper half-box and leading upward to the piston-pin. The piston-pin itself is hollow with its ends plugged, and is drilled near each end so that oil is fed directly to the bushings in the piston. The tube and piston-pin are thus filled with oil under pressure from the pump, so adequate lubrication is assured. The piston-pin is case-hardened and ground, and bears on bronze bushings pressed into the bosses in the piston.

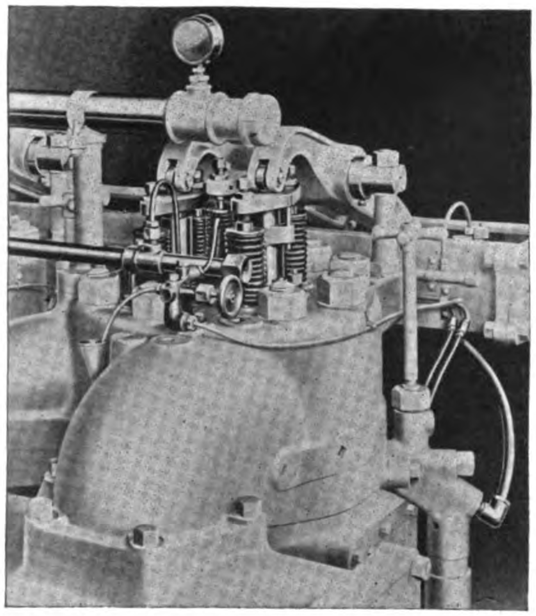
These piston-pin bushings are grooved so that the oil will reach all the pin bearing surfaces. The surplus oil escapes onto the cylinder wall providing ample lubrication for the pistons. Any access oil works down and collects in the crank case. It is thus seen that all bearing surfaces are assured of positive lubrication. The trunk pistons are about 75% greater in length than in diameter. The piston-pin bosses are located about one-third of the distance up from the bottom of the piston, which brings them to about the center of the effective bearing surface. The length of the bosses is such that the bronze bushings can be inserted from the inside. As each



Three-stage compressor piston

bushing is flanged, it is effectively locked against lateral motion when the connecting-rod is in place. The piston has the usual saucer-shaped top to give the necessary compression space and there are ribs from the underside of its top to the side walls and the bosses. The piston is also strengthened by a rib around the inside, just above the bosses. To prevent oil from splashing up under the lower side of the head where it would be burned, the hole thru this rib is closed by a light sheet-metal plate. This simple feature has great influence in maintaining the quality of the lubricating-oil which would otherwise rapidly become very dirty. The usual piston-rings are carried at the upper end of the piston. In order to prevent oil working up past the piston-rings, a groove is turned immediately below the lowest ring, and from this groove a number of holes lead back into the inside of the piston. To permit the handling of the bolt which clamps the upper end of the connecting-rod around the piston pin, each piston has a hole thru each side midway between the pin bosses and slightly above them.

The cylinders are cast individually with integral water jackets, there being large cover-plates so that the jackets can be readily cleaned out if necessary. The cylinders are bored and then ground to very close limits, assuring an excellent fit of the piston and rings. Each cylinder head carries five valves, two for the intake of air, two for the exhaust; each pair is operated from the cam-shaft by a single rocker-arm; the valves being connected by a T-head guide on which the end of the rocker rests. The guide is carried in contact with the rocker at all times by a coil spring in the center of its hollow stem. Each end of the guide carries an adjusting screw and locknut, by



Winton valve mechanism

which the clearance between the ends of the valve stem and slide can be adjusted. This clearance should be about 0.015" for both main inlet and exhaust valves. These pairs of valves are used instead of single large valves, as the small valves are much less apt to warp under the high temperatures to which they are exposed.

The fuel injection-valve is located in the center of the head, and is also operated by a rocker from the camshaft. The adjusting screw for this valve is set to leave 0.025-in. clearance when the valve is closed. All these clearances are those for a cold engine, and will be somewhat less as the engine warms up.

High-pressure injection air flows during all the time the injection valve is open. Fuel may be injected during part or all of this period, depending on the amount of power required from the engine. The amount of fuel is controlled by a centrifugal governor which limits the duration of the fuel-pump suction as may be required to maintain the engine speed.

The fuel-pump is of the plunger type, with one plunger for each power cylinder. It delivers the fuel to the fuel injection-valve under a pressure of 850 to 950 lbs, depending upon the pressure of the fuel injection-air. The stroke of the fuel-pump is constant, the amount of fuel delivered being controlled by the governor, by the early or late closing of the pump inlet-valve as noted above. The action of the governor is very delicate, as the speed variation with varying loads is very slight. This is, of course, an advantage in a marine engine with which the loads may vary from one extreme to the other as the ship's propeller is deeply submerged or approaches the surface of the water in rough weather. The fuel-oil is lifted to the fuel-pump from the tanks by air at 10 to 15 pounds pressure, insuring plenty of fuel at the pump inlet-valve.

For cooling purposes the engine cylinders and air-compressor are provided with circulating water by a 4-cylinder plunger pump, operating from the same crank-shaft which handles the oil circulating pump. The oil circulating-pump, which provides lubrication for all the main bearings of the engine, really consists of two single-cylinder pumps. The one driven from the end throw of the crank-shaft operating the circulating-water and lubricating oil-pumps, draws the oil from the pump in the lower half of the crank-case and forces it thru a cooler and a strainer to the storage tank. The other single-cylinder pump draws the oil from this storage tank and forces it into the header from which it is piped to the bearings, as described above. The discharge side of the pump is provided with an air-chamber to insure constant pressure being carried on these bearings. The circulating water-pump is of the four-cylinder type, and also has an air-chamber on the discharge side to insure steady circulation of the water. The cylinders, pistons and stuffing box glands are made of noncorrosive bronze to prevent injury by the water.

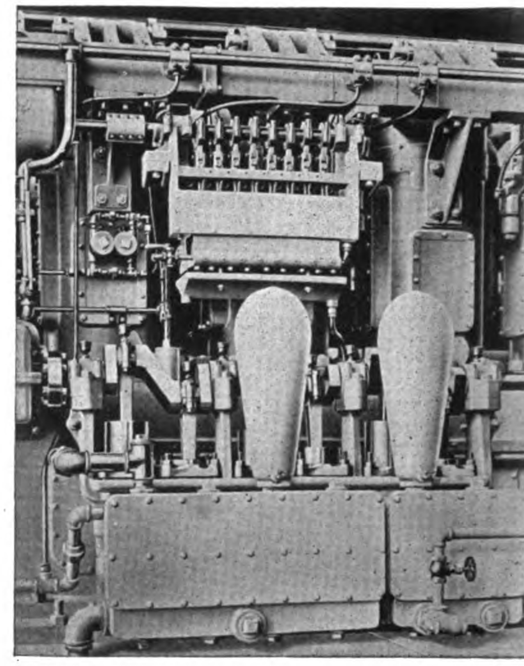
The camshaft is supported in a long box-shaped casting open at the top, which is in turn supported on brackets from the cylinders. This trough is partly filled with oil, insuring ample lubrication to the cams; the camshaft bearings are lubricated under pressure from the pump, as are its driving gears. The drive for the camshaft is thro bevel gears from a vertical shaft near the center of the engine which in turn is driven from a lay-shaft and a train of spur-gears at the front end of the engine. There are two complete sets of cams, for forward and reverse motion, respectively.

Lateral shifting of the shaft endways by means of a hand-wheel and suitable mechanism brings either set of cams into operation. The shift from full-speed ahead to full-speed astern is guaranteed in six seconds, but is frequently accomplished in five seconds. Considering the weight of the parts which must be brought to rest and started in motion again in the opposite direction, this is a splendid performance when compared with the reversing of the average steam marine engine.

The procedure required to reverse the engine is as follows:

1.—Close fuel-oil supply valve
2.—Shift camshaft
3.—Open fuel-oil supply valve.
4.—Open valve controlling starting-air
5.—Close starting-air valve

The supply of air for starting the engine is carried in steel air-bottles which are from 12 to 18 inches in diameter and ten to twenty feet long. These are stored wherever convenient on the ship, and connected by heavy brass tubing to a header running the full length of the engine. At the point where the pipe from the air-bottles join this header, is located a valve which can be opened by pulling on a long handle. This admits the air to the header. Each cylinder is connected to the header by means of a pipe in which is located a valve operated regularly by the camshaft The end of this pipe, connected to the cylinder, is fitted with a special casting containing three valves. The first is a check valve, to prevent the compression or power stroke pressure from escaping from the cylinder. The second is an overload —or safety-valve, which is set to open if the pressure in the cylinder exceeds normal power stroke pressure. A valve of this type is necessary to prevent damage to the cylinder or piston in case water or oil should accidentally collect in the cylinders. If this happens and the engine were started, the top of the piston would probably be broken out as water or oil is practically non-compressible. The third valve in this casting is operated by a small hand-wheel, and is opened only when it is desired to attach an indicator to determine the work being done by the cylinder.

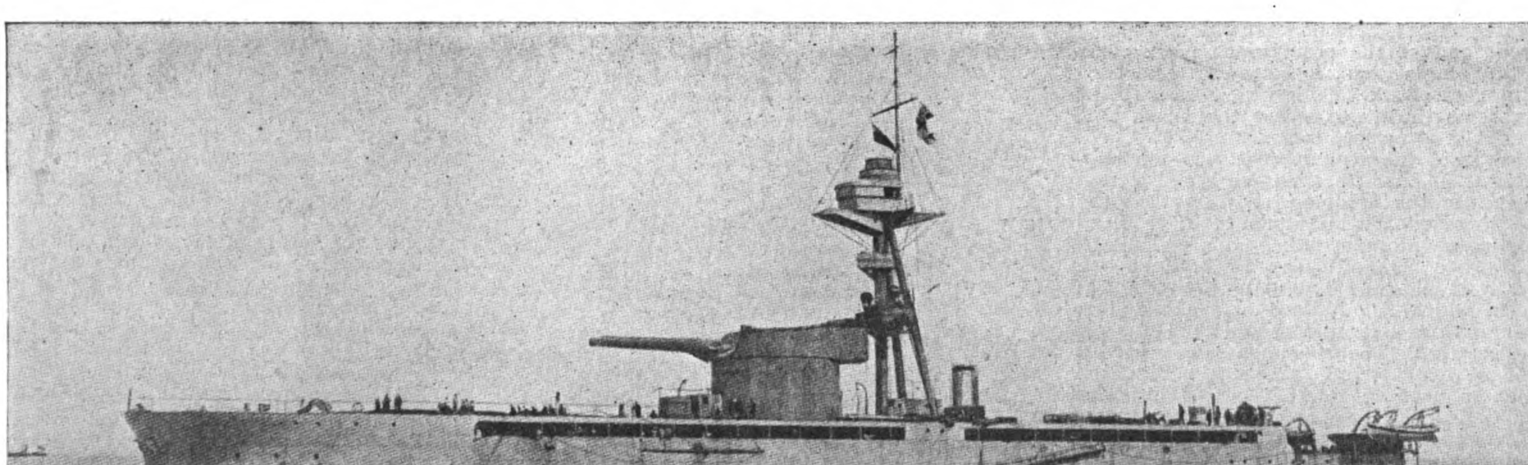


Fuel and water pumps on Winton engine

The air inlets for both the air-compressor and the main cylinders are connected to a large header, into which air is taken thru a muffler at each end. This arrangement of drawing air for the engine directly from the engine room causes a constantly drawing in of fresh air.

The surface or thrust-block at the rear of the engine lubricated under pressure from the engine oil-pump. This thrust-block consists of a short, heavy shaft, flanged at both ends; one flange being bolted to the rear flange on the crank-shaft. Turned integral with this shaft are a number of large collars, between which the horseshoe shaped thrust segments are mounted. Each of these segments is faced with babbitt on both sides and has a connection at the top to an oil lead from the pump. The babbitt facings are grooved so that the oil is distributed under pressure over the entire thrust surface. The segments are held in the proper position by nuts or heavy threaded shafts along each side of the thrust- block. They are consequently readily adjustable for wear. They also are reversible so that should the babbittt wear or burn off on one side, a new bearing surface can be brought into operation by a few minutes' work.

In general, the design has been very carefully worked out in conformance with the ideas of Mr. Winton. The best of materials have been selected for each part, and the workmanship is excellent. All these factors contribute to obtain the results which are reported each time a Winton engine equipped ship reaches port.



The White Diesel-driven monitor "Marshal Ney" which was described in our April 1919 issue, and on the same page, the "Marshal Soult" a sister motor-vessel was illustrated. Displacement 6,670 tons, length 340 ft., beam 90 ft. 3 ins., loaded draught 10 ft. 3 ins. Two 15 in. guns are mounted

The Importance of Ships to America

By SENATOR WESLEY L. JONES
(Chairman, U. S. Senate Committee on Commerce)

[In sending this article to "Motorship" just as we go to press, Senator Jones points out that he rushed the same to "Motorship" prior to a personal examination of the transcription of his dictation because he considers the matter so urgent.—EDITOR.]

THE United States is building ships. If the program that seems to be definitely mapped-out is carried through, about ten-million tons will be completed in the near future. These ships will be the property of the United States just as a man's machine is his property. What we will do with them and how we will use them is the immediate problem that confronts us.

Conditions are abnormal, commercial demands for ships are great and governmental needs imperative. These ships must be kept in use in the most efficient way. If not through private channels, then through governmental agency. Not only must this be done, but it must be done in such a way as to make the producers and consumers of the country, as well as the business interests, feel that their welfare has been duly regarded. We want the wise and patriotic counsel of all those interested in working this out. All desire the same great object and are moved by the same purpose and should seek patiently and considerately to work out the details wisely.

It is easy to make general statements as to what should be done or what we hope to do. The difficulty comes in actually framing a bill. I have sought to present some ideas which I have in the shape of a bill to meet the present situation. I submit it for criticism and suggestion. It may be found to be wholly impracticable. There may be some good in it, some bad. It recognizes the desirability of private operation as well as private ownership; but it also takes into account the very likely need of governmental support in many lines and especially in developing new lines to new markets. Its terms are plain and will be understood without my going into details. It is intended to care for the present situation until conditions shall become more nearly normal, and we can develop a wise and permanent shipping policy based upon normal conditions and upon the experience that will give us reliable facts and data to guide us.

The war found the United States with practically no merchant marine either in private hands or under governmental operation. Ships had to be built. The government was the only agency that could build them on the scale demanded, and so it entered into the ship building A large tonnage has been constructed and a larger tonnage is under way. If the program mapped out is carried through, about ten million tons will be completed in the near future. All these ships will be the property of the United States just as a man's machine is his property. What to do with them and how to use them is the immediate problem confronting us.

Shipping conditions are abnormal. The commercial demands for ships is great and governmental needs are imperative. These ships ought to be used in the most efficient way, if not through private channels, then through governmental agencies. They should be used in such a way as to make the producers and consumers of the country, as well as the business interests, feel that their welfare has been duly regarded. Whatever plan is proposed must not overlook the interest and rights of the people as a whole in these ships.

While the people no doubt realize that these ships have cost much more than they would have cost under ordinary and normal conditions and that they cannot be sold in the ordinary way for more than similar ships will bring in the open market, they will not be satisfied with the sale of these ships at low prices and on easy terms to private interests who may operate them under these abnormal conditions and secure enormous profits. Some believe strongly in government ownership and operation, but I believe that the great majority of the people of this country believe that private ownership and private operation of shipping will be much more efficient than government ownership or operation. One might well believe in government ownership and operation of railroads, and yet not believe in government ownership or operation of steamships and steamship lines. They exist and operate under entirely different conditions. Different methods must be pursued to make them a success. Private enterprise, energy and initiative are more imperatively required in connection with shipping than in connection with railroads. The people as a whole want their ships used in the way that will bring them the greatest good, but they will not look with favor upon any plan that may sacrifice their rights in these ships simply to get them in private ownership and private operation, regardless of what they are worth. We want wise, considerate and patriotic counsel in working out the immediate problem of these ships and their use. We all desire the same object, and are moved by the same purpose, and every plan should be considered free from any suggestion of ulterior motive.

NAVAL-CONSTRUCTOR J. L. ACKERSON
Mr. Ackerson now is in full charge of the U. S. Government shipbuilding, in addition to being Vice-President of the Emergency Fleet Corporation, as announced on page 19 of our magazine.

General statements as to what should be done or what we hope to do are easy to make. The difficulty comes in actually framing a bill to carry out general views. I have sought to present some ideas which I have tentatively formed to meet the situation in the shape of a bill. It may be found to be wholly impracticable. There may be some good in it. It is submitted for criticism and suggestion. I tried to keep in mind the conditions under which these ships have been produced, the interest of the people in them, the superiority of private operation and the need of using these ships to promote the welfare of the commerce and business of the country.

Ship owners, ship operators and shipping ports are not the only ones interested in shipping and ship transportation. In my judgment, the farmers, workers and business men of the interior of the country are in greater need of shipping than those on the seashore. Their products largely make up the surplus that must find a market abroad. If there are no American ships to carry this surplus, it must await the pleasure of foreigners and may be wasted, and the prices of such products be greatly depressed all over the country. These are the people who should realize the interest they have in a merchant marine. Instead of opposing steps—radical or unusual if need be—to promote an American merchant marine, they should insist upon having such service.

The bill which I have prepared authorizes the President, through the United States Shipping Board, to handle these ships along general lines, leaving to him, however, very great discretion. Our wooden ships are to be disposed of as soon as possible upon the best terms possible, the preference to American purchasers. It seems to be generally conceded that our wooden ships are not suitable for overseas trade, and that, unless sold, they will be practically a total loss. Steel ships of 3,500 tons and under are not suitable for overseas trade, but can be advantageously used in coastwise trade and in parts of the world like the Mediterranean, where long voyages are not made. The President is empowered to sell these ships to foreigners if they cannot be disposed of under the terms of the bill to American citiens. The President is authorized and directed to invite bids for ships to be employed in the coastwise trade and between the United States and its territories and possessions, and to sell ships for this purpose at not less than the price of similar ships in the open markets of the world. Under this provision the smaller ships which are suitable for coastwise trade ought to be disposed of.

There are private enterprises that originate and produce certain products that require a special class of ships. We have some ships suitable for such purposes, and the President is authorized to invite bids for their purchase by these persons or corporations.

There are citizens and companies operating regular passenger freight or regular passenger and freight service to foreign ports who very likely need additional ships to perfect their service. The President is authorized to invite bids from such persons or corporations to buy our ships to perfect this service.

It is very desirable that new routes shall be established to open up new markets for our commerce. The President is directed to ascertain what routes should be established, and he is then authorized to charter ships to the best and most responsible bidders to establish these lines. I think the bill should also provide first for the sale of ships to establish these lines, and I think the bill should be amended in this respect, if the preceding sections do not cover this situation. In selling these ships the bill thus far provides that they shall be paid for within three years, deferred payments to bear such interest as the President may fix, and in determining this rate, the President is authorized to take into account what is necessary to enable American ships to compete with foreign ships, and he can favor them in order to accomplish this purpose.

If shipping transportation is profitable during the next three or four years as is generally thought it will be, payment can well be made in three years and the man or company that has its ship paid for will be better able to weather the time of low rates, which is very likely to come, than the man whose ship is not paid for. If we sell on eight or ten years' time now, many ship operators might find themselves unable to meet the payments and return their ships to the United States after having reaped the profits of high rates,

Tramp or cargo ships are needed to go to all points of the world for freight. Private enterprise and initative is especially necessary to make these boats a success. Ships that cannot be sold for this purpose, the President is authoried to charter upon such terms as he may think best to the best and most responsible bidders, and in doing this, he can take into account what may be necessary to enable these ships to compete with foreign ships.

If there are ships that the President cannot sell or charter advantageously, he is authorized to operate these ships for developing, extending and holding new foreign markets.

It is thought that many of these ships might be sold for a price equal or nearly equal to the cost of building even though that cost may be abnormal or if the payments are extended over a long period of years and at a very low rate of interest and possibly even without interest. This may at first seem a rather startling proposition but if the people can get the money that they have put in one of these ships back, they will very likely be satisfied just as they have been satisfied for the government to expend money in the reclamation of arid lands to be repaid over a long period of years without interest. In other words, the government is not especially concerned in getting interest on its money if it gets its money back.

If the people have put a million dollars in a ship, they will be pretty well satisfied if they get this million dollars back in twenty or twenty-five years, without interest, and the man who wants to purchase a ship, if he will sit down and figure it out will find he can as well afford to pay a million dollars without interest as he can afford to pay five hundred thousand dollars for the ship with interest on deferred payments of four or five percent, and so the President, by this bill, is authoried to invite bids of this character when he invites bids for the purchase of ships, and can use his discretion as to which proposal to accept.

Sales and chartering of ships must be made to American citizens or firms composed of American citizens or corporations sixty percent of the stock to be owned by American citizens.

They are to be officered, manned and operated under the laws of the United States.

Authority is given for requiring ample bonds for the faithful performance of any contract whether a contract of purchase or a contract of charter.

Special direction is given to the President to consider the establishment of shipping lines in the Pacific Ocean to South America and to countries and ports not served by American ships, and I think that a further provision should be inserted in the bill giving the President authority to use some of these ships in providing for connection between Pacific ports and the Alaska Railroad, either through private enterprise or through government agencies. If private enterprise cannot or will not make ample connection with this railroad, so as to virtually extend it to Pacific ports, there is no reason why the government ships should not be used for that purpose especially so long as the government owns and operates the railroad.

This is an outline of the bill proposed. It can be perfected by criticism and suggestion, especially by those who are familiar with the needs of the country and shipping transportation methods and requirements.

MILLER FREEMAN NOW A CAPTAIN

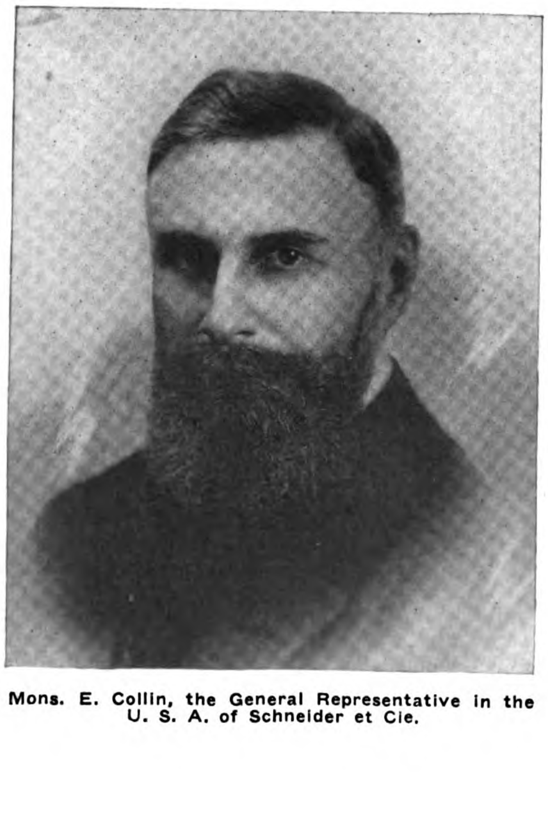
As we anticipated our worthy, but modest Chief threatened us with dire penalties for having said some nice things about his splendid war-work in our March issue. Nevertheless, we take great pleasure in giving him a little more publicity. For, in recognition of his preeminent qualifications for advancement in the U. S. Navy, and as a testimonial of his efficiency and for the services he gave to the country throughout the war, promotion to the next higher grade in regular line has been bestowed upon Commander Miller Freeman.

We may again mention, for the benefit of many new readers of "Motorship," that Captain Freeman is the President of Miller Freeman & Co. Publishers of "Motorship." After he was placed on the retired list at the close of the war, he was immediately re-drafted for public service, and now is secretary of the Veterans Welfare Commission, which was created by the last legislature and entrusted with the expenditure of $500,000.00 for the relief of returned soldiers.

Captain Freeman's promotion is particularly noteworthy, inasmuch as only four other commanders were advanced. Captain Freeman organied the Washington State naval militia, served as its commander, and was in command of the naval training-camp at the University of Washington during the entire period of the war. He was the originator of the plan for the camp at the University, and had supervision of the construction work before the camp was placed in commission.

THE SCHNEIDER COMMISSION IN THE U. S. A.

During the War Messrs. Schneider & Co., the great French engineering and shipbuilding firm, have maintained a large organization in America. At the head of this Commission, and acting as General Representative of the Company, is Monsieur Emile Collin—a distinguished Alsatian engineer who graduated from the Central School of Paris, and from the Electro-Technical Institure of Liege, Belgium. Ever since his graduation, which was over twenty years ago, Mr. Collin has been associated with Messrs. Schneider, and he gained his first practical engineering experience in their artillery works at Le Havre. Afterwards he headed many commissions in foreign countries—particularly Scandanavia and South America—most of them being for the purpose of supervising the testing of Schneider guns by army officers of those countries; other commissions were in connection with the building of public-works, harbors, bridges, etc., that had been undertaken abroad by the Schneider company.



Mons. E. Collin, the General Representative in the U. S. A. of Schneider et Cie.

Prior to the war, Mr. Collin resided in South America, having spent many years in Mexico, Peru, Chili, Argentine, Brazil, Uraguay, Bolivia, and Venezuela, where he displayed considerable energy and ability in transacting business in the face of competition of Krupp and other German commercial methods. Thanks to his excellent capabilities as an engineer and business man he is very well-known in all these South American Republics, and his genial manner won him many good friends in both business and social circles.

At the beginning of the War, Mr. Collin served as Captain of artillery in the French army, but was released because of his valuable knowledge of design and construction of large guns. Messrs Schneider & Co. sent him to New York to take charge of their very important purchase in this country that ran into many millions of dollars, and which were made in order to increase their output of guns and ammunition. He also was placed in charge of the financial negotiations with American Banks which involved very large amounts of money.

Under the direction of Mr. Collin, the Schneider mission in the United States was greatly extended and consisted of over one-hundred persons, including metallurgical-engineers and foremen; specialists in the making and production of steel for shells, also experts in the manufacture of cartridge-cases, copper-bands, shells, guns, etc.

From the end of 1917 the Schneider Commission has continuously given assistance to the U. S. Ordnance Departments in connection with the construction of the famous 155mm. and 240 mm. Schneider-type howitzers built in this country for the American army.

In the occasional absences of Mr. Collin from this country, his place is taken by his assistant, Monsieur Aimé Dumaine, who, by the way, also graduated from the Central School of Paris, and who has been connected with Messrs. Schneider & Co., for eighteen years. His first association with the firm was as technical-engineer of artillery at the Creusot plant. He made many trips to South America for the Company, and for the eight years prior to the War he resided in that continent. When the War broke out Mr. Dumaine was manager of the Bolivian General Enterprise, of La Paz, Bolivia—a subsidiary of Schneider & Co—which position he resigned to join the French army as a Captain of Artillery. After a year at the front, he was released and sent to the United States to assist Mr. Collin.

THE PRODUCTION OF AUXILIARY MACHINERY FOR MOTORSHIPS ON THE PACIFIC COAST.

Typifying the rapid growth of Seattle's Industries, is the rapid stride that has been made by the Pacific Machine Shop & Manufacturing Company, occupying four acres of waterfront property on the Duwamish Waterway. Starting in 1914. in a small shop on the waterfront across from Pier 8, with a few small tools and engaged in repair work for small fishing vessels, this concern is now situated in a big modern plant.

While still looking after a great amount of repair and installation work on large steel and wood vessels, the principal volume of business comes from the manufacture and sale of auxiliary machinery for steamships, motorships, barges and sailing-vessels, such as steam and electric steering-gears, steering telmotors of the well-known McTaggart-Scott design for which this company holds the American License.

Noteworthy among this production has been the development of a full line of auxiliaries driven by electric motors, primarily intended for motorships having crude-oil burning main engines, and to obviate the necessity of carrying a donkey-boiler on board to provide steam for the auxiliaries. After a few installations had been made, it developed that not only did the electric auxiliaries do all that steam had previously done, but that cargo could be handled with greater dispatch, due to the perfect control while operating costs proved to be very much less, from the standpoint of the crew and the owners, the electric auxiliaries were much to be preferred.

It is the firm belief of Mr. Allan Cunningham and Mr. George E. Sweet, president and general manager, respectively of this company, who have given a great deal of their time and study to these problems, that the future American Merchant Marine to be owned by Americans and operated by Americans, which we must have to develop and maintain our Foreign Trade relations, must severely suffer, unless some concerted action is immediately taken by American interests to build motorships that will successfully compete with steamships and motorships of Foreign register.

AMERICAN MACHINERY IN NEW ITALIAN MOTORSHIP YARD

For the purpose of building Diesel-engined steel auxiliary sailing-vessels a new shipyard is being erected at Crotona, Italy, by Messrs. Gio. Ansaldo & Co. This yard is being equipped with American machinery.

ANOTHER AMERICAN 4,000 B.H.P. SUBMARINE

The A. A. 3, a submarine of 4,000 b.h.p. was launched at the Fore River plant of the Bethlehem Steel Co. on May 24. She is powered with four Nelseco Diesel engines of 1,000 b.h.p. each.

Mons. A. Dumaine, the Assistant General Representative of Schneider et Cie.

Vickers High-Powered Submarine "Diesel" Engines

Eight and Twelve Cylinder Motors of the "Solid-Injection" Type---Eighteen-Hundred Maximum B.H.P. Developed on a Weight Well Below 50 lbs. per Horse-Power--- Successful Use of Cast-Steel Cylinder Heads

PREVIOUS to and during the war a rigid secrecy was maintained concerning the heavy-oil engines built by Vickers, Ltd., of Barrow-in-Furness for submarines of the British navy. Little was known except that they were of the four-cycle "Diesel" type, with solid-injection of fuel, contrasting with the compressed-air injection of fuel used by the machinery of all other submarines. Never during these periods has a photograph or a drawing of a Vicker engine appeared in the technical press, much less a description of the design. That any benefit was derived from this over-secrecy we frankly are dubious; for, while giving full credit to the most excellent Diesel engine development work accomplished by Messrs. Vickers, there seems to be an opinion in naval circles that for submarine work the Augsburg (German) four-cycle type marine Diesel engine is unsurpassed in all-round design, construction and reliability by those of any other nation's engineers. The policy of secrecy never has been stringently adopted by the Augsburg works, where the Diesel engine originally was developed by Dr. Rudolf Diesel and Herr Imanuel Lauster. Yet no builder appears to be ahead of these, so far as high-speed Diesel engines are concerned, but we would not endorse such an opinion at this time.

"Motorship" has always believed that the policy of open discussion of technical problems met with in the design, construction and operation of Diesel engines produces advantages to the individual builders concerned, which outweigh anything that can be gained by keeping the knowledge—often dearly purchased—from rival engine builders. Nothing will be better for rapid expansion of the industry than a frank discussion of troubles as well as how good results are obtained, and a mutual exchange and use of all experiences and developments.

As regards the secrecy maintained by Vickers, Ltd., we presume that the British Admiralty was entirely responsible for the same, as, immediately the Navy Censors lifted the ban, "Engineering" of London, to whom we are indebted, was enabled to give a general description of the Vickers submarine engines.

Owing to existence of standard spare parts of the Vickers engine at British naval stations all over the world, any radical departure in the design of the principal features, was avoided; but, nevertheless in developing the direct-reversible model it was possible to make the main parts interchangeable with the non-reversing type, and at the same time, to make the weight less than that of the non-reversing engine of the same power and cylinder dimensions.

In the large E, L, and J class submarines engined by Vickers, eight-cylinder non-reversing and twelve-cylinder direct-reversible engines are installed, and these are of the four-cycle type with solid-injecion of fuel on the McKechnie principle, so, strictly speaking, are not of the true Diesel cycle, as Dr. Diesel's patents distinctly refer to fuel-injection by compressed-air. Nevertheless, the Vickers engine otherwise operates on a cycle that is the Diesel, so if not a Diesel engine, it is of the Diesel type. So only by "splitting hairs" can we say that the Vickers engine is not a Diesel motor?

The construction of both their eight and twelve-cylinder models is very similar, so that one description almost suffices.

All cylinders in both engines are 14½-in. diameter by 15 ins. stroke, and each cylinder easily develops 100 brake-horsepower at 380 r.p.m. Powers up to 50 per cent in excess of this have been obtained at higher speed, which would mean 1800 b.h.p. from the 12-cylinder engine; but a conservative rating has been followed by the Admiralty authorities. It is plain that high ratings must result in reduced durability, and the consistently steady running of the submarines year in and year out appears to point to the soundness of this policy. Evidently, Vickers preferred to increase the number of cylinders to obtain this power rather than increase the cylinder bore and stroke.

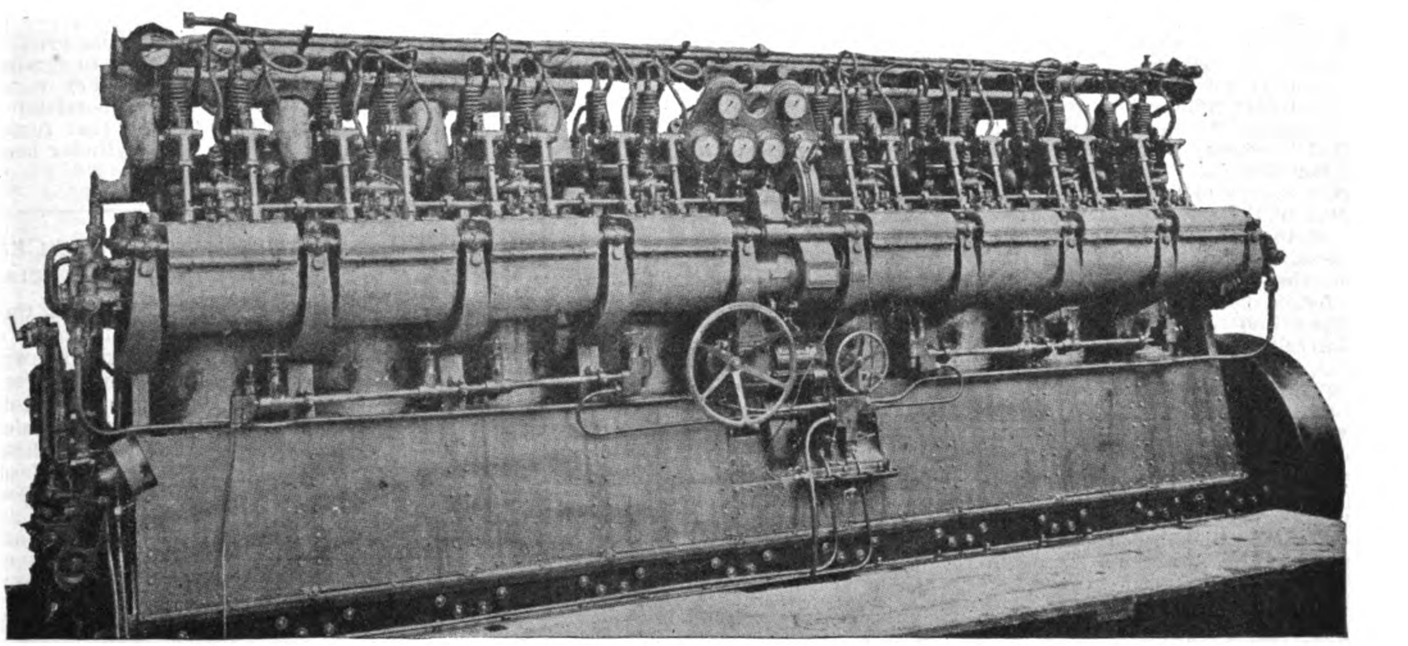
The Vickers construction is in principle a very light one, and even with the low rating results in a weight per brake-horsepower of 58 lbs. for the bare engine, calling the power 1,200 b.h.p. for the 12-cylinder engine. This weight is reduced to below 50 lbs. if the power be taken as 1,400 h.p., which is easily obtained, and weight ratio would be very materially decreased if the piston speed were increased to the high figures of 1,323 ft. per minute, as is said to be obtained in some of the German "U" boat engines.

With the maximum output of about 1,800 b.h.p. the weight is indeed exceedingly low; but, in service, we doubt if this output ever is attained. In the J-class submarine, three of these engines are installed. One of the AE class submarines with two eight-cylinder engines ran 30,000 miles without having to be refitted.

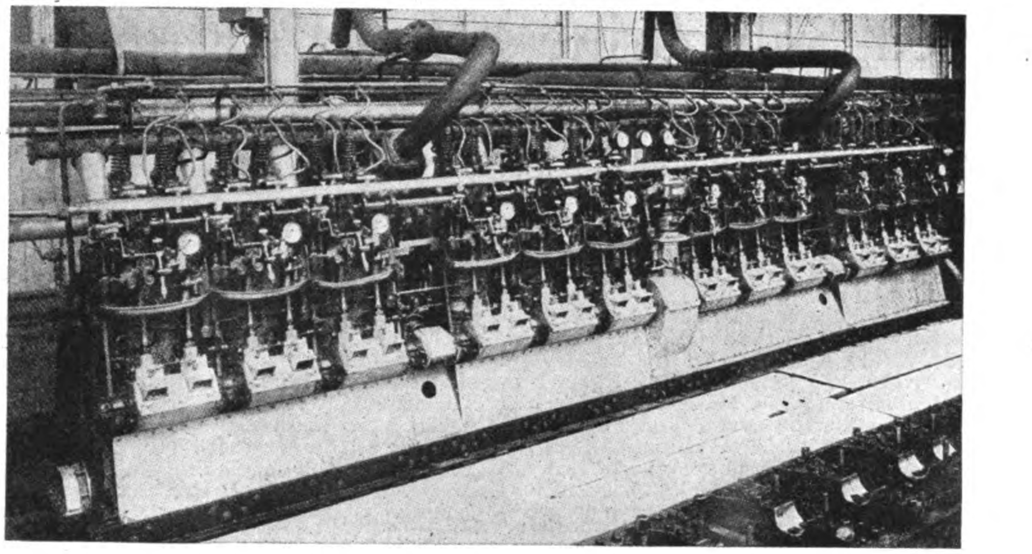
The cylinder covers are of cast-steel of simple construction, secured to the sandwich plate and to the columns. The joint is made by a cast-iron ring ground into grooves in the liner and in the cover. Water connections between the jacket and cover, consist of tubes through the sandwich plate, passing into holes in the bottom of the cover, water-tightness being secured by soft packing-rings around the tubes. Although no cylinder pressure relief-valves are fitted, we understand that no submarine engine cylinder-head cover has been known to fail in a Vickers' engine. If this is the case, and we have no reason to think otherwise, then Vickers have made very important progress with Diesel engine construction, and more details of the cylinder-head design and method of casting the steel, together with the mixture formula, would be of great value to the marine engineering world.

The valve-cages are separate from the cover, and are fitted upon coned seats in recesses in the cover. The valve-cages are water-cooled by water from the cover. This water, in the case of the exhaust valve, passes into the jacket of the exhaust bend. The valves are of nickel steel, and the exhaust-valve is water-cooled through flexible hoses. The piston is of cast-iron, with six upper rings and one wiper ring. They are not water-cooled. An aluminum guard is fitted above the gudgeon to prevent oil splashing upon the crown. The connecting-rod is hollow, of round section, with separate bottom-end and compression liner. The crank is closed by portable sheet casings, and is ventilated by suction-pipes to the induction header, non-return valves being fitted in the suction-pipes to eliminate any possibility of a backfire into the crank-pit. The above-named features are common to both engines.

We come now to points of difference between the two engines. The 12-cylinder engine has the inlet and exhaust cams on a lower camshaft actuating the valves through push rods. The upper camshaft carries the fuel cams and drives the fuel-injection pumps, one to each cylinder. This separate pump design is that originally preferred by the naval engineers, but the spray-valves have proved themselves such accurate means of regulating the fuel injected that a common fuel supply is now finding favor, and this is fitted in the reversing design. In this latter case the fuel is pumped into a common main from which are branches leading to the separate cylinders. No gags are required, as for air-injection engines with a common fuel supply. This common supply pump is a four-throw pump driven by spirals from the end of the crankshaft. In the 12-cylinder engine the pump discharges may be connected at will, thus resulting in running on the "common rail" system, as used in the eight-cylinder engine shown. The use of the common pump permits of one camshaft only in the reversing design. This shaft carries all cams, the air-starting cams being at the ends of the engine. The short push-rods for the inlet and exhaust rods are pulled away from the cams by the rotation of a fulcrum-shaft, after which the camshaft is moved longitudinally, and the push-rods are then replaced upon the cams for running in the opposite direction. The fuel and air cams are bevelled, permitting the camshaft to slide without their tappets being lifted. All reversing is carried out by hand, it being desirable to avoid



The Vickers eight-cylinder 900 b.h.p. solid-injection type "Diesel" submarine engine



The Vickers 12-cylinder, 1200-1400 b.h.p. solid-injection "Diesel" submarine engine

servo-motor gear, which generally gives trouble after some time at sea.

The 12-cylinder engine has the standard spray-valve with external gland. The reversing engine has a flooded valve, in which the spindle does not project through a gland, but is actuated by a bell-crank, the rotating shaft passing through a gland in the side of the valve-box. Both types give equally good results, and choice is made according to the ease of adaptation to the valve mechanism.

In each case the engine is started by compressed-air. The air is admitted in correct sequence by tappet-valves with a spring and a balance piston upon them. By this means the valves are lifted off the cams when the air master-valve is closed, and they only come into action when starting or reversing is required. The air passes to each cylinder through a non-return valve on the cover. The mechanical injection is so safe in its operation that there is no necessity to shut off the air before admitting the fuel. In the reversing-engine it is arranged that the starting-wheel shuts off air when all cylinders are on fuel, but in the non-reversing type the two are not interconnected. As already mentioned, cylinder relief-valves are fitted to these engines, although in the reversing engines, such are fitted to comply with the standard specification. The fact that the Vickers submarine non-reversing engine has no cylinder relief-valves is practically evident of the strength of the parts and of the safety of the injection system. Such a design is, of course, unusual.

The cast-steel main-bearing girders are connected longitudinally by forged beans. There are plate columns between the cylinder covers and the main-bearing girders to relieve the cylinders of all vertical stress.

A cast-iron liner is dropped into a sandwich-plate between the covers and columns, and is thus free to expand downwards. A jacket of steel plate, corrugated for expansion, is fixed to the sandwich plate at the top, and is fitted with a sliding-joint at the bottom between the jacket and the liner. Thrust reactions are taken by snugs butting against the bottom of the liner where it passes through the top plate of the crankcase. This top plate serves to tie the columns together.

The control is different in the two engines. We may describe first that of the 12-cylinder engine. One handwheel in the centre controls the opening of all of the spray valves. Individual cylinders can be put in or out of action by the handles at each cylinder. A second hand-wheel controls the output of the fuel-pumps by sliding a shaft upon which are mounted stirrups moving the scroll-cams actuating the suction-valve of each pump. The horizontal wheel advances or retards the injection of moving vertically a coupling in the vertical shaft. This coupling is free to slide vertically on one part of the shaft, but drives the other through inclined keys. By this gear the upper camshaft can be rotated a few degrees relatively to the crankshaft. This gear is a refinement, enabling the spray-cams to be set with great convenience to meet any conditions of fuel or load-speed ratio, which may vary considerably in a submarine charging when running on the surface, and it is not fitted to the reversing engine in which the duration of the injection is so related to the first instant of injection throughout the range of control that automatic regulation sufficient for satisfactory running in all ordinary conditions is obtained. An emergency stopping-valve is also fitted to the 12-cylinder engine, which releases the pressure from the rail.

The eight-cylinder engine control may now be described. The large hand-wheel seen in the view is for reversing, and a small hand-wheel interlocked with the first wheel admits air to all cylinders, then fuel and four cylinders, then fuel to the second four, and shuts off air. A further turn stops the engine by shutting off fuel. The pump output is controlled by a small lever regulating the closing point of the suction-valves. The large upper lever controls the spray-valve opening.

For the high-pressure pump, or solid-injection system used in conjunction with the fuel-spray-valve, Sir James McKechnie was responsible. It has, of course, many advantages. Possibly it also has its disadvantages. For instance, the exhaust is said to be always very dirty. Perhaps Messrs. Vickers will advise us on this point. It always has been understood in America that with solid-injection of fuel the fuel-consumption is about 10 per cent higher than the consumption of Diesel engines with compressed-air injection; but, we are told that these latest Vickers engines have a consumption of about 0.40 lb. per b.h.p. hour, and that as low as 0.381 lb. has been recorded at full load on official trials with engines built during the urgency of war-time.

This we would like to have Vickers confirm by means of test reports. Because, with such consumptions, if they can be regularly maintained such as when in the hands of the average American merchant-ship engineer, very few advantages are left to the air-injection type of engine, as with the solid-injection system, the high-stage air-compressor, its weight, space, complication, and attendance are avoided.

The McKechnie-Vickers system has previously been described in "Motorship," and consists simply of a high-pressure pump supplying the fuel to a main, from which a definite amount is admitted each firing-stroke by a measuring-valve in the cylinder-head, and passes to a simple spraying-nozzle. The power is controlled by varying the duration of the opening of the spray-valve, and at the same time adjusting the pump to the pressure required. Years of trial have been necessary to obtain the results now given, but in its present development the injection is reduced to the simplest possible terms. The result is a system which can be run with little previous knowledge and with a minimum of attention or danger due to carelessness in adjusting.

Finally we may refer to several points of the general design of the Vickers engine: The first is the accessibility gained by the plate column construction, which the illustrations do not show to advantage. The second is the conservative rating and stresses. Thereby extreme durability is obtained and serious breakdowns are avoided. The weight per brake-horsepower of an engine should always be considered in connection with the rating and stresses allowed. The third notable feature is the avoidance of special methods of manufacture. While the best material and workmanship are used, special steels are aid to be avoided, as also are heat treatment of details and parts requiring very special tools or processes of manufacture. Thus spur-wheels are used wherever possible in preference to spirals. The engine thus becomes an ordinary manufacturing and refitting proposition, and no danger arises if a broken part is replaced in ordinary material. Such a policy permits boats to be sent to foreign stations with more assurance than if they were dependent for upkeep upon expert supervision during repair. Nevertheless, we think that further details concerning the cast-steel cylinder heads would make interesting reading.

NEW BRITISH MARINE OIL-ENGINE MANUFACTURERS' ASSOCIATION

For the purpose of protecting the trade interests of the marine oil-engine industry, a new body has been registered in England, known as the British Marine Oil-Engine Manufacturers' Association. This society also will promote the development and research and discussions of technical questions.

The subscribers are: A. Gilchrist, 36 Finniston Street, Glasgow; R. P. Doxford, Sunderland; G. F. Tweedy, Neptune Works, Newcastle-on-Tyne; J. Brown, Scotts' Shipbuilding and Engineering Co., Greenock; J. Fleming, care of Palmer's Shipbuilding and Iron Co., Jarrow-on-Tyne; J. M. Ferguson, Victoria Works, Rugby; J. W. Harper, J. S. White and Co., Cowes.

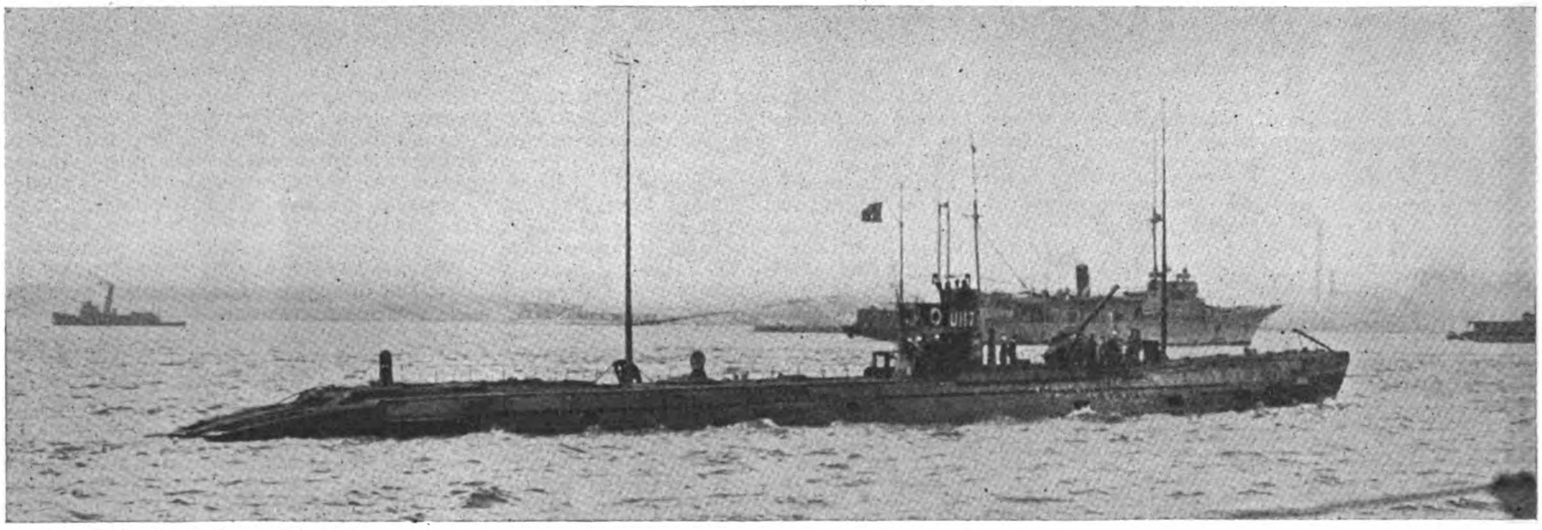
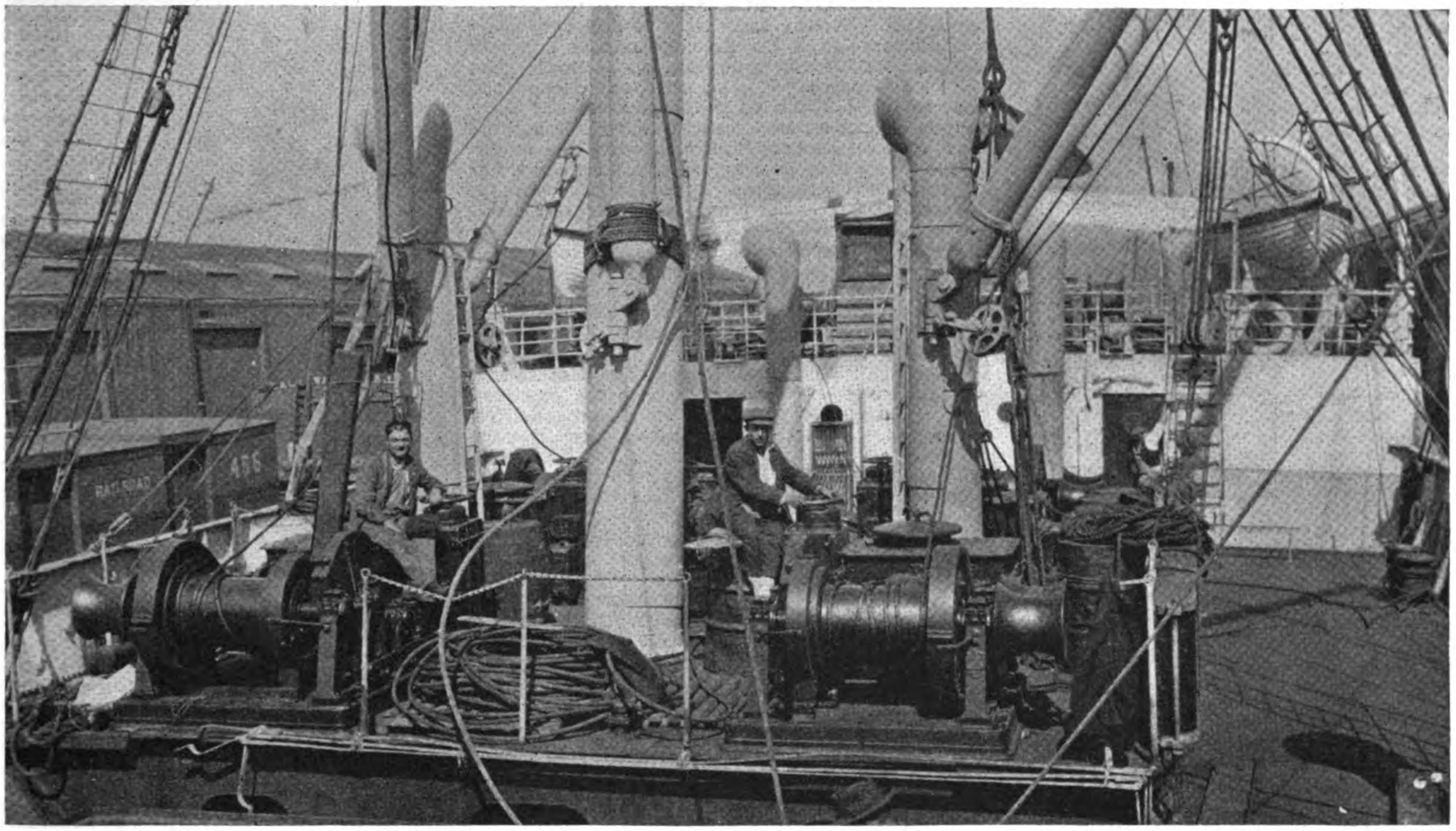


Photo. Copyright, Underwood & Underwood.

The German submarine U-117 in New York harbor. She is propelled by two Augsburg four-cycle Diesel engines of about 1,200 b.h.p. each



Two Swedish electric winches aboard the British-built, Danish-owned motorship "Falstria"

The Working of a British-Built Motorship

The M.S. "Falstria," of the East Asiatic Company Has Nearly 160,000 Nautical-Miles at an Average Speed of 9.15 Knots to Her Credit—Used Total of 4,915 Tons of Fuel, or 0.031 Tons per Sea-Mile with 6,000 Tons of Net Cargo in Holds

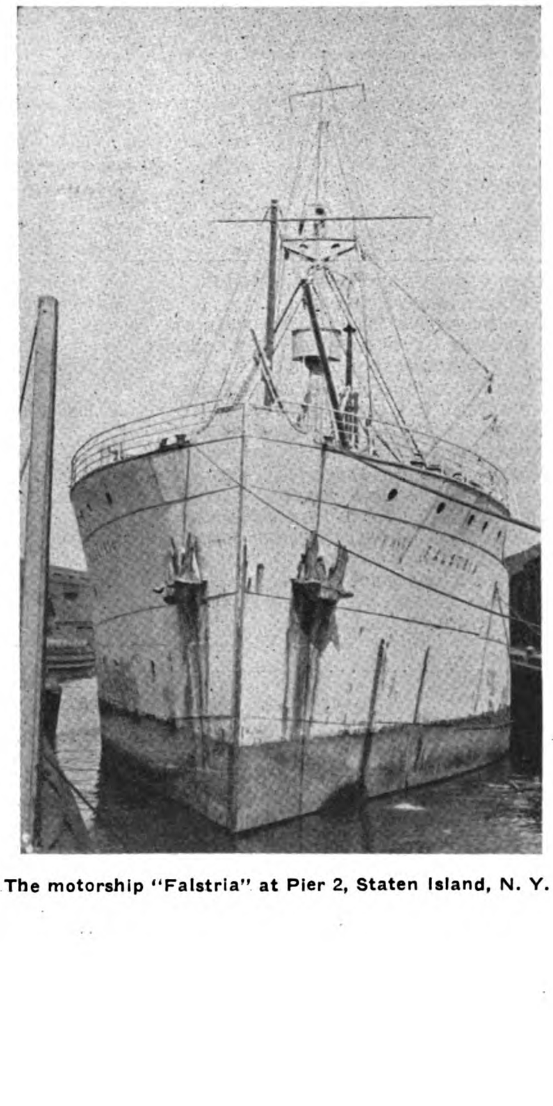
PROBABLY we inspect more merchant motorships than anyone else—in fact, our entire time is devoted to the study of oil-engined vessels and their performances, so obviously we are in a better position to form reliable conclusions regarding their success and operation than those shipowners who have merely visited a few such craft, also those domestic shipbuilders who may have made repairs to the comparatively few earlier-built Diesel-engines that have given serious trouble.

Every motorship we visit leaves us more and more convinced of the reliability and practicability of the modern oil-engined vessel. We do not suggest that these motorships operate month after month, year after year, without the slightest vestige of mechanical trouble, because there does not exist such a perfect vessel—steam-driven or otherwise. But, we do insist upon asserting that over 95 per cent of the large Diesel-driven merchant ships in service are maintaining regular operations equal to or better than a similar percentage of the steam-driven vessels in service today. In other words, motorships are actually doing the work required of them. Their performances are such that including the time occupied in oil-engine alterations, and repairs, and the cost thereof, steamships cannot compete over the same route with motorships under normal trade conditions.

One hears all sorts of stories—often grossly exaggerated—about cracks in the cylinder-heads of Diesel engines. In the past, far too much importance has been placed by shipowners upon this point and a little light should be cast upon this matter.

When a crack occurs it does not mean that the engine is instantly thrown-out of business, and that the ship has to be towed to the nearest port, and stay there for weeks while being repaired.

In many cases cylinder-heads are seven or eight years old and do not show any signs of cracking. With others, cracks commence to develop after about two years' operation. Occasionally a faulty casting will produce a crack in a few days. But as a general rule, cracking is a gradual process, and engines will run for months with a cracked head, consequently the engineers usually wait for a favorable opportunity to replace the cracked cylinder head with a spare one when in some port. Such work is carried out by the ship's engineers, and without any outside assistance. The cost only amounts to a few hundred dollars per cylinder, and rarely is a modern motorship delayed because of this. This cost, of course, is very insignificant compared with the enormous economies otherwise effected, and when compared with the tremendous value of the additional cargo-carrying capacity resulting from the use of the class of machinery with which these over-rated cracks sometimes occur. But, let us make it quite clear that cracks are the exception to the rule, and when they do occur it is not to all the cylinder-heads, but only to one or perhaps two, so that over a period of several years the cost and loss of time is practically negligible.



The motorship "Falstria" at Pier 2, Staten Island, N. Y.

With the Diesel engines of the motorship that we are about to discuss, it has been found that the cylinders cracked—at such time when they have cracked—after about two-years working, and when they safely pass this two-year period, they do not subsequently crack. In any event a crack less than six inches long does not worry the engineers, and until the crack becomes larger than that they do not replace the cylinder-head. One cylinder-head which cracked and replaced with a spare, has been repaired with two circular steel plates, and was, we noted, that it was ready for replacement, should another cylinder crack at any future time. Altogether there have been only a very few cracks with the motors of this particular ship.

We mention these matters in order that, in future, shipowners will not attach too much importance to "cracks." The repair bills of the majority of modern motorships would surprise shipowners by their smallness, generally being much less than the repair bills of the boilers, condensers, etc., of the average tramp steamer.

In this issue we are able to give a record of the performance of a large motorship built in Great Britain during the early part of the war, under license from a Danish company. Her engines were constructed before their builder had done sufficient work to gain proper experience. In several respects with the installation they seem to have departed a little from the Licensor's designs—perhaps unwisely—that is to say, judging by comparisons with duplicate vessels built by the Danish company. Generally speaking, the layout of the engine-room is not so good as these of other motorships with the same design of engine. Also, the engineers say that the materials are not

so good. The latter, of course, may only be in the minds of engineers who are Danes, and who naturally would think that anything built in their own country is better than built by foreigners. However, it was apparent to us that the general arrangement of the machinery in the engine-room is not so nice as in some other ships we have been aboard. Incidentally, we have seen much worse.

Chief-Engineer Jacob Jacobsen of the motorship "Falstria"

Nevertheless, with the above assumptive "handicap," this vessel theoretically should have been unreliable, and an expense to her owners, and a source of trouble to her engineers. But, in actual service, she has put up a very fine performance and commercially has been a success.

We refer to the motorship, "Falstria," built by Harland & Wolff for the East Asiatic Company of Copenhagen, Denmark, and engined by the Burmeister and Wain Oil Engine Company of Glasgow (now the Diesel-Engine Department of Harland & Wolff). She left Glasgow for her maiden voyage on April 5, 1915. Her dimensions are as follows:

Loaded displacement on 23½ ft. draught	8,900 tons
Dead-weight capacity	6,700 tons
Net-Cargo capacity of holds (with general cargo)	5,700 tons
Bunker capacity (110 days at full-speed)	843 tons
Water and stores	157 tons
Maximum Net-Cargo carried in holds not including fuel and water	6,000 tons
Gross register	4,500 tons
Length O. A.	381 ft. 0 in.
Length B. P.	365 ft. 0 in.
Breadth	50 ft. 0 in.
Depth	29 ft. 0 in.
Loaded draught	23 ft. 6 in.
Number of propellers	Two
Total main-engine power	2,400 I.H.P. at 120 R.P.M.
Total power of engine-room auxiliaries	260 I.H.P.
Fuel-consumption per 24-hour day (including auxiliaries)	7 to 7½ tons
Speed of ship (loaded)	10 knots
Total engine-room staff (no firemen)	12 men

As a rule the load-line is three feet above the water line, both on short and long voyages, and she has a very large cargo-capacity compared with a steamship of similar loaded displacement, dimensions and speed. On a 7,000 mile voyage the "Falstria" would carry from 800 to 900 tons more than a steamer, or enough additional income for freight carried to buy dozens of cylinder-heads, apart from the great saving in fuel and other economies. On this voyage to New Work she brought 6,000 tons of jute, hides, and skins; in addition to fuel and water.

Shipowners will do well to compare this with the hold-capacity (not the misleading dead-weight capacity) of their own oil-fired and coal-burning steamship of similar dimensions. It is 75 per cent of the loaded-displacement of the ship; while the dead-weight capacity figures out at 67 per cent of the displacement. Thus, it is easy to understand why we say the term *dead-weight capacity* is misleading if used when both motorships and steamships are being compared.

Shipbuilders and naval-architects will notice that of the 8,900 tons displacement, the cargo, bunkers, water, stores, etc., amount to about 6,700 tons of which 6,000 tons is net cargo and 700 tons is fuel, water, etc., which leaves 2,200 tons for hull and machinery.

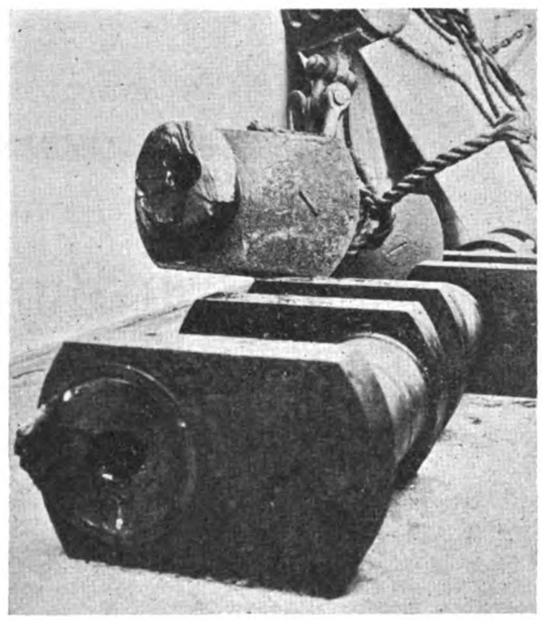
Thus per ton of structural steel cargo-carrying capacity of the motorship is very large. In other words, the first cost of the ship per net-cargo ton is lower than that of oil-fired steamer of the same dimensions, even if we assume that the Diesel-engines of the motorship cost 15 per cent more than steam machinery.

It will not be amiss also to compare the running of the motorship, "Falstria," with the performances of steamships of similar tonnage. We think this motorvessel will make a fairly good showing, although we have published records of Diesel-driven vessels that have done better. On this page are given extracts from her log.

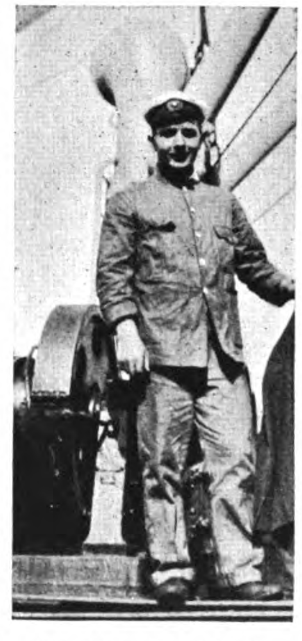
Regarding the fuel-oil used, this is obtained from Borneo, and is named Taraken crude. As the "Falstria" bunkers sufficient for 110 days at full-speed without interfering with her cargo-capacity or without using her deep-tank for fuel, it will be understood that she has no difficulty in securing low-priced fuel. This Taraken oil comes from Borneo and is used straight from the wells without refining. It is very heavy (0.9361 specific gravity) and thick, but as a rule does not have to be heated. At the same time, it is a very clean oil, and free from the deposits usually found in Mexican and Texas crude-oils, so is fairly good for Diesel-engines. It is plentiful, and cheap when motorships can fill their bunkers in the East, because transportation costs are saved. When the East Asiatic Company first decided to run motorships, they wisely contracted for a large supply of oil for many years ahead—it is said 20 years—at a very low price. For many years Taraken crude-oil also has been used with success by the oil-carrying motorships of the Asiatic Petroleum Company. This latter concern, by the way, should not be confused with the East Asiatic Company, with whom it has no connection whatever. One is British-Dutch, and the other is Danish.

Now, the fleet of motorships of the East Asiatic Company regularly call at U. S. ports, and load with American products and manufactures. Therefore, we can at this juncture ask Mr. Edward N. Hurley, our worthy Shipping Board Chairman, how can American oil-fired steamers, using 35 tons to 60 tons per day of domestic fuel-oil at $1.00 to $1.75 per barrel, compete in the carrying of our own goods with these economical European motorships using but 7 to 12 tons of foreign fuel-oil at $0.50 to $1.00 per barrel? We refer to vessels of 6,500 to 12,000 tons in each instance.

With such conditions before us it is nothing more or less than folly to build any steam-driven freighters of under 15,000 tons. All vessels from 3,000 to 15,000 tons should be Diesel-driven, otherwise America's merchant-marine dreams will receive a shattering blow, as indicated recently in a telegram from Senator Phelan to Franklin K. Lane, Secretary of the Interior.



Whenever a fracture has occurred to a crankshaft of a Diesel engine of a motorship the shaft invariably has been a Krupp production, and the fracture has been due to too hard steel—probably too much carbon. This illustration of the crankshaft of one of the 120-h.p. auxiliary motors of the "Falstria" clearly shows that the crack was almost entirely due to the steel being too hard



The M.S. "Falstria's" Second-Engineer— Mr. L. Splittorff

Undoubtedly, the time has come to remove both coal and oil-fired steam-machinery from all American steamships built during the war, and replace the same with economical Diesel machinery which will afford us a respectable chance of keeping our cargo carriers on the high-seas, when full-cargoes are scarcer and when freight-rates are less than they are today.

First-officer O. Munch Moller, of the "Falstria," is enthusiastic regarding the sterling qualities of his ship, both from operating and cargo-carrying viewpoints, and from her maneuvering abilities. From Calcutta via Columbo the Suez Canal and Philadelphia to New York she only used 360 tons of this Borneo fuel-oil, yet she had a little over 6,000 tons of net "dividend-earning" cargo in her holds, apart from the bunkers, water, and stores.

Such a fundamental economic must win, and nothing can stop its advance. Those who now do everything to assist construction and development of the motorship will benefit the most. America cannot have the best motorships and the most reliable oil-engines unless shipowners and the Government do their share of tangibly encouraging development work by sharing responsibility with the ship and engine builders. Those shipowners who sit by and content themselves by saying that "they will order motorships when they are reliable"—soon will be unable to see transportation of domestic products in American hulls because of the foam churned by the propellers of the motorships of foreign-owned freight lines.

Cannot those shipowners realize that the motorship already is a practical and demonstrated commercial economic, and that further waiting on their part will not produce additional development or perfection? Every motorship ordered today and built is another step towards perfection. If we do not build, how can we perfect this class of power?

To return to our discussion of the "Falstria."

VOYAGES OF THE MOTORSHIP "FALSTRIA"
(From April 5, 1915 to End of April 1919.)

Route	Distance	Time	Fuel Consumption	Average Speed
From Glasgow and round the world to Copenhagen, Denmark	37,644 Nautical Miles	4,018 Hours	1,283 Tons	9.36 Knots
Copenhagen to New York thence via Panama Canal to Vladivostock, and to Copenhagen via the Suez Canal	30,502 Nautical Miles	3,275 Hours	1,098 Tons	9.34 Knots
Copenhagen to Bangkok via Suez Canal and back to Copenhagen	20,868 Nautical Miles	2,229 Hours	780 Tons	9.36 Knots
Copenhagen to San Francisco via Panama Canal and back to Copenhagen	35,467 Nautical Miles	3,805 Hours	1,283½ Tons	9.32 Knots
NOTE:—On this voyage both engines made a non-stop run of 72 days, from Singapore to Norway via Cape of Good Hope, excepting a halt at Sierra Leone for the regular Lloyds' inspection.				
Copenhagen to South America, up and down West Coast, thence to Suez	22,754 Nautical Miles	2,733 Hours	973½ Tons	8.25 Knots
*Suez to Calcutta thence to New York via Philadelphia	10,620 Nautical Miles	1,080 Hours	357 Tons	9.83 Knots
*NOTE:—On this voyage she run from Calcutta to Philadelphia, or 48 days without a stop except when passing through the Canal.				
Total	157,855 Nautical Miles	17,140 Hours	5,775 Tons	9.15 Knots

USEFUL NOTES FROM RECORDS OF THE MOTORSHIP "FALSTRIA"

Average Daily Run over Four Year Period	219.6 Nautical Miles.
Average Fuel-Consumption of Main Engines	6-1/10 tons per 24 hour day, or 135 grammes per I.H.P.Hr.
Total Daily Consumption of Engines and auxiliaries together	7 to 7½ tons per 24 hour day
Fuel-Consumption of ship (loaded) per Nautical Mile	0.031 Ton.
Fuel-Consumption per Net-Cargo Ton Mile (with maximum load aboard)	0.000186 Ton.
*Net-Cargo Capacity (maximum) Percentage per Loaded-Displacement Ton	76%
*Dead-Weight-Capacity (maximum) Percentage per Loaded-Displacement Ton	67%
Fuel-Oil Used	Taraken Crude of 0.9361 Specific Gravity.
Cost of Fuel Consumed in carrying 6,000 tons Net-Cargo a distance of one Mile	21-7/10 Cents.

*NOTE:—With fuel-bunkers and water tanks fully loaded.

There are a total of 12 men in her engine-room consisting of
Chief-Engineer....................Jacob Jacobsen
Second-Engineer....................L. Splittorff
the Third-Engineer, one Electrician, four union-engineers, and four greasers. No first or fourth-engineers are carried.

Regarding lubricating-oil, the oils usually used are Vacuum, D. T. E. heavy, and Veritas No. 7. Of 10 tons of lubricating-oil shipped six months ago, only 5 per cent has been consumed, the oil being filtered and used over again. Compared with the new De Laval centrifugal oil-cleaner, the filter-tank system used aboard the "Falstria" is clumsy, bulky, and slow in action.

The marine-engines of the "Falstria" are of Burmeister & Wain four-cycle design, each having six-cylinders 560 mm. (22.047 ins.) bore by 760 mm. (29.921 ins.) stroke, and were designed to turn at 140 r.p.m. In the ship they turn at an average of about 130 r.p.m., the rating having been lowered a little from the original output. The "Falstria," by the way, is a sister-vessel to the "Kangaroo," ex "Bostonian," first owned by the Leyland Line and sold to the Western Australian Government. The "Kangaroo" became noteworthy for being the first cargo-vessel to realize over $100.00 per d.w. ton. This was in the earliest days of the war, when tonnage was cheap.

The "Falstria" has two four-cylinder Burmeister & Wain design Diesel-engines of 120 i.h.p. driving auxiliary air-compressors, and electric generators. The latter are of 153 b.h.p., 455 amperes, 220 volts, and 100 k.w. at 200 r.p.m. The Diesel-engines are of too little power for the generators, which, by the way, were built by the Allmanna Svenska Elestriska A/B of Stockholm, Sweden. Because of this underpowered drive not a little trouble is given by the auxiliary Diesel engines.

Recently a crankshaft broke. This shaft was made like other Krupp crankshafts in motorships —of too hard steel. Such crankshafts as have been broken in motorships invariably have come from the great Krupp works at Essen, Germany. Probably there is too much carbon in the steel. We give an illustration of the crankshaft showing this facture.

In the engine-room of the "Falstria" there also is a single-cylinder Tuxham surface-ignition type two-cycle oil-engine of 20 b.h.p. This drives a 110 volt 100 ampere 11 k.w. electric-lighting plant. Finally we will mention that although this is a British ship, all the electric-winches and electric-motors are of Swedish make.

British Submarines

Sir Eustace Tennyson D'Eyncourt, K.C.B., read a most valuable paper on British naval construction during the war before the Institution of Naval Architects (England) on April 9th last, in which he gave drawings and complete details of all the latest British warships, including the H.M.S. "Repulse." Sir Eustace, in discussing their submarines, said that in the "J" class they had produced the fastest Diesel-driven submarine, a speed of over 19 knots being obtained. The power of the Diesel engines is 3,600 b.h.p. per boat.

Regarding the "K" class submarines, the steam-turbines were used for full-speed on the surface and the 800 b.h.p. Diesel engine was used just before diving, and for getting away quickly after coming up from below the surface, transmission from the Diesel engine being through electric motors. Thus the K-submarines had gear-transmission for the turbines, electric-transmission for the Diesel engine and electric-battery drive for submerged propulsion. He said, however, the Germans had the advantage of more power per cylinder in their Diesel engines, but the British produced faster submarines and were more heavily armed.

The M.I. was a monitor-submarine with a 12 in. gun. Sir Eustace lists the British submarines as follows, but omits the dimensions of the Diesel-driven monitor-submarine M. I.

British Sub [illegible]arines.

	"E" Class.	"G" Class.	"H" Class.	"J" Class.	"K" Class.	"L" Class.
Length between perpendiculars	180 ft.	185 ft.	164 ft. 6 in.	270 ft.	334 ft.	222 ft.
Length overall	181 ft.	187 ft.	171 ft.	275 ft.	338 ft.	231 ft.
Lreadth, extreme	22 ft. 6 in.	22 ft. 6 in.	15 ft. 9 in.	23 ft.	26 ft. 6 in.	23 ft. 6 in.
Boad draught, mean	12 ft. 6 in.	13 ft. 3 in.	11 ft. 3 in.	14 ft.	16 ft.	13 ft. 6 in.
Displacement in tons, surface	660	700	440	1210	1880	890
Displacement in tons, submerged	800	975	500	1820	2650	1070
Shaft horse-power of engines, surface	1600	1600	480	3600	10,000	2400
Shaft horse-power of engines, submerged	840	840	320	1350	1400	1600
Speed at load draught, knots, surface	15	14	13	19	24	17½
Speed at load draught, knots, submerged	10	10	10½	9½	9	10½
Oil fuel capacity, tons	45	44	16	91	200	76
Armament	1 3 in. 5 18 in. T.T.	1 3 in. 4 18 in. 1 21 in. T.T.	— 4 21 in. T.T.	1 3 in. or 4 in. 6 18 in. T T.	1 4 in., 1 3 in. H.A. 8 18 in. T.T.	1 3 in. or 4 in. 6 18 in. T.T.

RELIABILITY OF SUBMARINE DIESEL ENGINES

One of the British A. E. Class submarines ran 300,000 nautical miles before it became necessary to undergo a re-fit of her "Diesel" and electrical propelling machine.

DENNY-BUILT SUBMARINES

Four Sulzer Diesel-driven submarines aggregating 2,940 tons and of 7,200 h.p. have been built during the war by Wm. Denny Bros., Ltd., Dumbarton, Scotland. These are the L-9 and the E-52, E-55, and E-56. The L-9 is of 930 tons and of 2,400 h.p.

BRITISH NAVAL TANK "SERVITOR"

During the war two 450 h.p. Scott-Fiat Diesel oil-engines of the two-cycle type were completed for the R.F.A. tankship, "Servitor" (built at the Royal Dockyard, Chatham), by Scotts Shipbuilding & Engineering Co., Ltd., Greenock, Scotland.

"FEROL" A ROYAL FLEET AUXILIARY

There has been placed in service by the Fairfield Company, Ltd. (Shipbuilders), Govan, Glasgow, Scotland, the Diesel-engined Royal fleet auxiliary, "Ferol," a vessel of 780 h.p. This firm also built the submarines E-37, E-38, E-47, and E-48, all of 809 tons and of 2,000 h.p.; also, the submarines L-15, L-16, and L-55, each of 1,100 tons and of 3,000 h.p. They also built the combination steam-turbine and Diesel-driven submarines K-14 and K-22, both of 2,620 tons displacement and of 10,000 i.h.p.

THREE NEW MOTORSHIPS FOR BRITISH ADMIRALTY

Three steel motorships were built during 1918 for the British Admiralty; two by Wm. Gray & Co., Ltd., West Hartlepool, England, and one by Short Bros., Ltd., Sunderland, England, and Bolinder oil-engines are installed in all three vessels. Their names are "Oakol," "Palmol" and "Teakol," and judging by their names, and because the machinery is installed aft, we presume they are tankers. The two built by Grays have the following dimensions, and the ship built by Shorts is practically the same size and power.

Gross tonnage	1,144 tons
Net tonnage	516 tons
Length	210 ft. 0 ins.
Breadth	24 ft. 6 in.
Depth	16 ft. 6 ins.
Power	640 b.h.p.

In each vessel two Bolinder surface-ignition two-cycle type oil-engines are installed, and each engine has four-cylinders 16 9/16 in. bore by 18¾ in. stroke. The dead-weight capacity of each ship probably is about 1,750 to 2,000 tons.

BRITISH DIESEL-DRIVEN SUBMARINES OF 3,900 B.H.P.

The triple-screw J-class British submarines are equipped with three twelve-cylinder, four-cycle type, 1,300 b.h.p. Vickers solid-injection "Diesel" heavy-oil engines, and have a surface-speed of 19 knots.

THORNYCROFT'S WAR WORK

The 1,600 h.p. submarines E-33 and E-34 and the 900 h.p. submarine F-3, were built and Diesel-engined by Messers. John I. Thornycroft & Co. of Basingstoke and Southampton, England, during the war. They also constructed additional engines for submarines to the total of 10,800 h.p., in addition to the engines and hulls of many fast 50-ft. coastal naval motorboats. This apart from 29 destroyers and flotilla leaders aggregating 36,210 tons and 957,000 i.h.p., and 11 other craft of 5,318 total tons and 7,800 h.p. This is quite an output to be proud of.

TWENTY OIL-ENGINED BARGES AND BEARDMORE SUBMARINES

During the war, Messrs. Wm. Beardmore & Co., Ltd., of Dalmuir, Scotland, built twenty oil-engined barges for the transport of men and horses. Beardmore surface-ignition oil-engines were installed. They also built the following Diesel-engined submarines:

Class	Displacement Tons	Power I.H.P.
K-16	2,600	10,000 (800 b.h.p. in Diesel)
L- 6	1,030	2,400
L-69	1,100	2,400
L-70	1,100	2,400
E-25	800	1,600
E-26	800	1,600
E-53	800	1,600
E-54	800	1,600
E-47	500	480
E-48	500	480
H-49	1,000	960
H-50	1,000	960

The L-class submarines are fitted with 12-cylinder Diesel engines erected and tested by Beardmore.

BRITISH NAVAL DIESEL ENGINES

The war-time output of J. Samuel White & Co., Ltd., East Cowes, Isle of Wight, England, included Diesel engines for H.M. warships, "Indus," "Fisgard," and "Marshal Ney," for two British submarines, one of 1,600 b.h.p. and one of 900 b.h.p., and Diesel engines for the Japanese Navy. They also built a number of motorboats. The H.M.S. "Marshal Ney" is illustrated on another page. This firm also completed 22 T.B.-destroyers, of which 9 were of 1,400 tons displacement and of 28,000 h.p. Altogether they built 41 flotilla leaders, destroyers, submarines, and patrol-boats of 42,620 tons and 831,500 h.p., also 60 small craft.

LIST OF MARINE DIESEL-ENGINE BUILDERS

To the list of marine Diesel-engine builders published in our last issue should be added the firm of Frichs Engineering Works, Aarhus, Denmark, builder of the "Frichs" four-cycle type engine.

FRENCH OIL-ENGINE BUILDERS' ASSOCIATION

An Association of Manufacturers and Users of Internal-Combustion Engines has been formed in France, which will co-operate with the Diesel-Engine Builders' and Users' Association of Great Britain in promoting the interests of users and manufacturers of heavy-oil engines.

LAUBEUF (SCHNEIDER) SUBMARINES BUILT IN GREAT BRITAIN FOR ITALY

We understand that during the war four Laubeuf type submarines have been built by Sir Wm. Armstrong, Whitworth & Co., Ltd., Newcastle-on-Tyne, England, from designs by Messrs. Schneider & Co., the well-known French engineers and shipbuilders, whose extensive facilities are given in the special art supplement presented with this issue. These submarines are known as the W-Class, and were transferred to the Italian Admiralty, in whose service they rendered splendid work.

THE STILL-ACKLAND HEAVY-OIL ENGINE.
Greater Thermal Efficiency than the Diesel-Cycle Claimed.

Before a gathering of engineers at the Society of Arts, London, on May 26, some interesting details were revealed regarding the Still-Ackland heavy-oil and steam engine, which has been developing for about eight years under the joint supervision of Mr. Wm. Joseph Still and Mr. F. E. D. Ackland. The inventors claim an efficiency 10% better than the Diesel-cycle, and that over 50% of the fuel energy is utilized.

As previously indicated in the columns of "Motorship" the Still-Ackland engine is a combination of steam and internal-combustion principles. Steam is raised from the heat that usually is carried away in the cylinder cooling-water and exhaust, and is admitted to the underside of the piston. Thus the down-stroke is on the Diesel-principle but on the upstroke the engine is operated by steam. For marine work it is claimed that the Still-Ackland engine weighs 20% less than a geared-turbine plant. Nearly two years ago one of America's great banking and commercial corporations sent several well-known engineers to England and made a most thorough investigation of this engine but did not take any further action. These investigations must have cost them not less than $10,000.

BUNKER FUEL OIL

Bids Received by the United States Shipping Board for 5,400,000 Barrels

Bids for bunker fuel-oil were opened on April 22nd last by the Division of Operations, United States Shipping Board, Emergency Fleet Corporation. The oil is to be furnished as required for one year from the date of award to the maximum quantity of 5,400,000 barrels. The bids received were as follows:

	Delivery 1 Grade B (Dollars)	Grade C (Dollars)	2 Grade B (Dollars)	Grade C (Dollars)	3 Grade B (Dollars)	Grade C (Dollars)	Panuco C Crude (Dollars)
BOSTON							
500,00 to to 800,000 bbls.							
Pan-American Petroleum		1.05		1.10			
Standard Oil of N. Y.	1.54	1.26	1.61	1.33			
PHILADELPHIA							
700,000 to 1,000,000 bbls.							
Atlantic Refining Co.	1.47	1.36.5	1.53.3	1.42.8	1.63.8	1.53.3	
Sun Company	1,51	1.36	1.60	1.45	1.76	1.61	
Texas Company	1.26	1.15.5	1.32	1.21.5	1.52	1.41.5	
Pan-American Petroleum		1.10		1.17			
GALVESTON							
400,000 to 600,000 bbls.							
Sun Company	1.26	1.20					1.00
Henry L. Doherty & Co.							
Texas Company	1.15		1.25		1.40		
CRISTOBAL							
1,500,000 to 2,000,000 bbls.							
Standard of N. J.		1.30					
Henry L. Doherty & Co.							1.23
Texas Oil Company	1.42						
Pan-American Petroleum		1.12		1.20			
BALBOA							
500,000 to 1,000,000 bbls.							
Standard of N. J.		1.44					
Henry L. Doherty & Co.							1.43

Orders for fuel-oil recently were placed by the U. S. Shipping Board as follows:

Galveston.—Four hundred thousand to 600,000 barrels. To the Magnolia Oil Company of Texas on their low bid of ninety-seven cents a barrel for Grade "C" oil on first delivery, and eighty cents for Panuco crude.

Philadelphia.—Seven hundred thousand to 1,000,000 barrels. To the Pan-American Petroleum Company of New York on their low bid of $1.10 per barrel for Grade "C" oil, first delivery, and $1.17 per barrel, same grade, on second delivery.

Boston.—Five hundred thousand barrels. To the Pan-American Petroleum Company of New York on their low bid of $1.05 per barrel for Grade "C" on first delivery and $1.10 for second delivery.

Cristobal.—Twelve hundred thousand to 1,750,000 barrels. To the Pan-American Petroleum Company of New York on their low bid of $1.12 for Grade "C' on first delivery and $1.20 on second delivery.

THE BRAZILIAN MOTORSHIP, "ITAMARACA"

In our issue of July, 1918, we gave some illustrations of the Brazilian steel auxiliary-motorship, "Itamaraca," owned by the Companhia Nacional de Naregacao Costeria of Rio de Janerio. The vessel was the old steel sailing ship, "Parkdale," built in 1891, but fitted in February, 1919, with two four-cylinder two-cycle type Sulzer-Diesel engines of 240-290 b.h.p. at 240-260 r.p.m. As she maintains 7 knots without sails the motors are used most of the time as, although underpowered, she really is operated as a "full-powered" ship. Recently the "Itamaraca" made another trip across the Atlantic to Cardiff, Wales, via La Havre, France, and her two engines ran for 19 days and nights without stopping.

The Sulzer-Diesel engines are of the port-scavenging two-cycle type, with four-cylinders 11.02-in. bore by 16.53-in. stroke, and are of the trunk-piston design without crossheads and guides. After over two years continuous service the only spares supplied to both engines have been one-dozen piston-rings, one piston, and one starting-valve, and the latter was broken through the carelessness of shore engineers, when the engines were opened-up for Lloyd's inspection.

Her engine-room even consists of the Chief-Engineer (a Scotsman), Second-Engineer (Italian), Third-Engineer (Brazilian), Fourth-Engineer (Portuguese), three oilers and a trimmer. A shipping-man who recently visited the "Itamaraca" said the chief-engineer's log-book is disappointingly uninteresting, as the Diesel engines have performed with monotonous regularity day and night. The fuel consumption of both engines together is 2.75 tons (19¼ barrels) at 240 r.p.m., or about 0.48 lb. per b.h.p. hour. Mexican oil is mostly used as fuel. Lubricating-oil consumption is about 6.6 gallons per day and the cylinder-oil consumption is 3.96 gallons daily. Pistons are cooled by water through telescopic-pipes and no trouble results from this.

OIL-ENGINE TESTS.

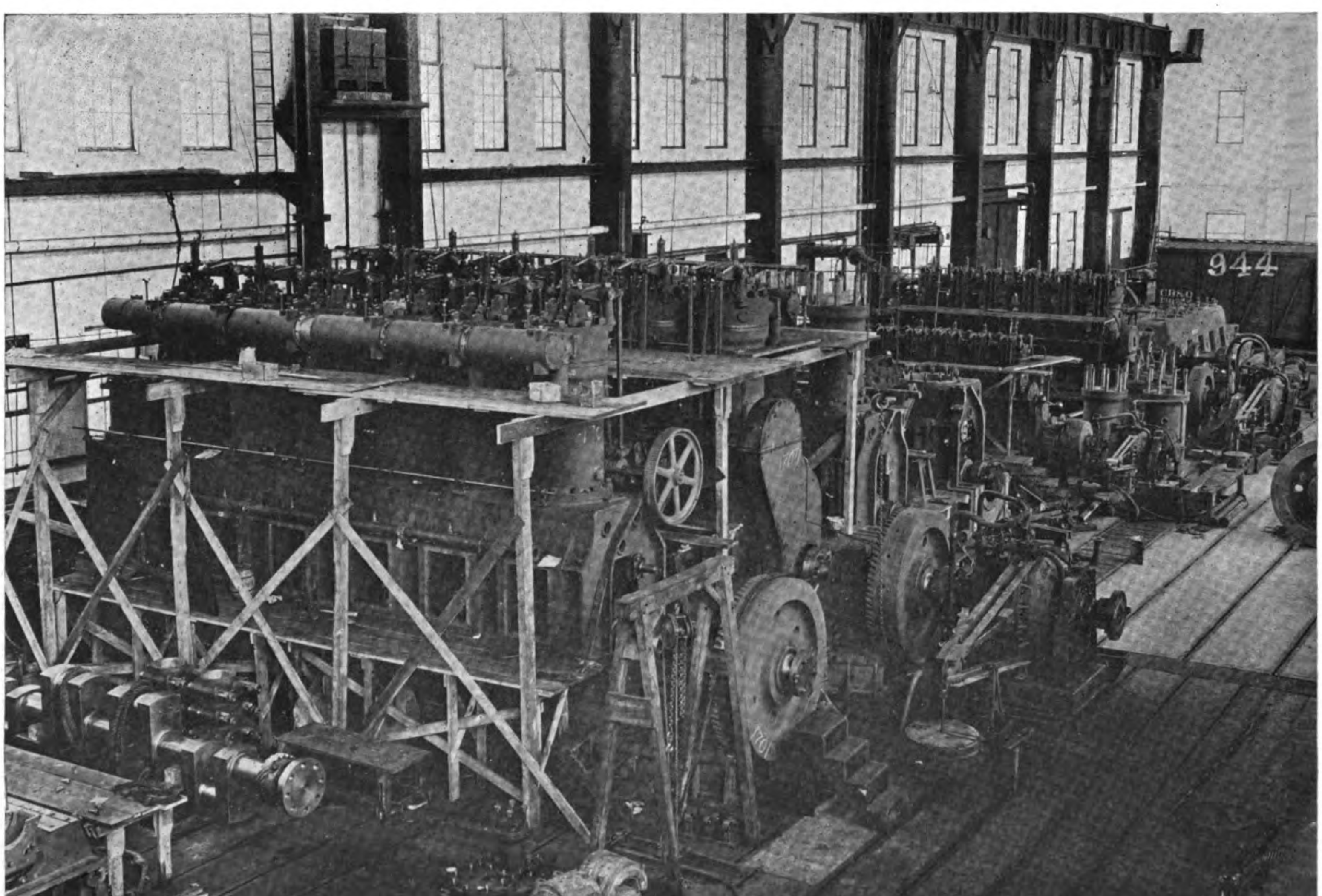
Some interesting tests were recently made with an oil-engine rated at 117 b.h.p. at 180 R.P.M. by Crossley Bros., Ltd., Openshaw, Manchester, England. The tests lasted four days and included a test on tar-oil. The engine was a single cylinder 18½ ins. bore by 28 ins. stroke model.

Fuel	B.H.P.	Oil per B.H.P. per hour. Lbs.	Heat units per B.H.P. per hour. B.T.U.	Thermal efficiency on the B.H.P. %
Kerosene (Calorific value 18,500 B.T.U. per lb.)	145.0	0.432	7,992	31.84
	123.0	0.427	7,899	32.22
	96.0	0.424	7,844	32.44
	61.3	0.455	8,417	30.23
	29.8	0.627	11,599	21.93
Residual Petroleum (Calorific value 18,000 B.T.U. per lb.)	142.0	0.457	8,226	30.93
	125.0	0.425	7,650	33.26
	96.7	0.424	7.632	33.35
	30.9	0.647	11,646	21.85
Tar Oil (Calorific value 16,200 B.T.U. per lb.)	146.0	0.514	8,420	30.22
	129.0	0.504	8,207	31.01
	102.0	0.475	7,750	32.84
	67.0	0.488	8,140	31.26
	32.0	0.700	11,850	21.47

At the conclusion of these tests there was no carbon deposits on piston, valves, or combustion chamber, the engine being as clean as if it had been worked on town gas.

MOTORSHIP "LIBBY MAINE" MAKES ANOTHER GOOD VOYAGE

A telegraphic report received from our Seattle office states that the Dow-Diesel-engined motorship "Libby Maine" has just completed another 15,000 mile trip—thus imitating her previous successful voyages.



After end of a pair of 750 b.h.p. McIntosh & Seymour Diesel engines just prior to starting on a 30 days non-stop test for the U. S. Shipping Board Emergency Fleet Corporation. A Heenan & Froude dynamometer is being used, also on the smaller engines in the background.

Slow-Combustion Engines and Their Uses

Together With Some Details of the Schneider Cross-Head Type Merchant-Marine and Naval Diesel Engines

By J. DROSNE*

(Engineer-in-Chief, Schneider & Co., France)

THE type of motor which has come to be called the "slow combustion," or Diesel engine, was introduced to the industrial world barely twenty years ago, and it has already been put to a large and varied number of uses in all spheres of activity, in electric-generating plants, in navigation, and even in railroad traction.

The history of this new type of heat engine is extremely interesting, for it clearly demonstrates the interconnected roles played in an industrial invention by the scientific conception, the study of the machine design and, finally, the practical production and experimental tests.

In fact—and this is no longer a secret to anyone today—the original conception of Rudolph Diesel, as set out in his thesis, "Theory and Construction of a Rational Heat Engine, Destined to Replace the Steam-Engine," was truly indeed a grave thermodynamic error. The inventor desired primarily to obtain a cycle identical with the Carnot cycle, that is to say, limited by two adiabatics and two isothermals. The compression of the air alone in the working cylinder gave one isothermal and one adiabatic of the cycle; the combustion was supposed to supply the other isothermal, with the assumption that the injection of the fuel were adjusted in such a manner that the combustion would be effected without increase in temperature. As for the exhaust period, it was supposed to be found at a point in the curvilinear quadrilateral diagram.

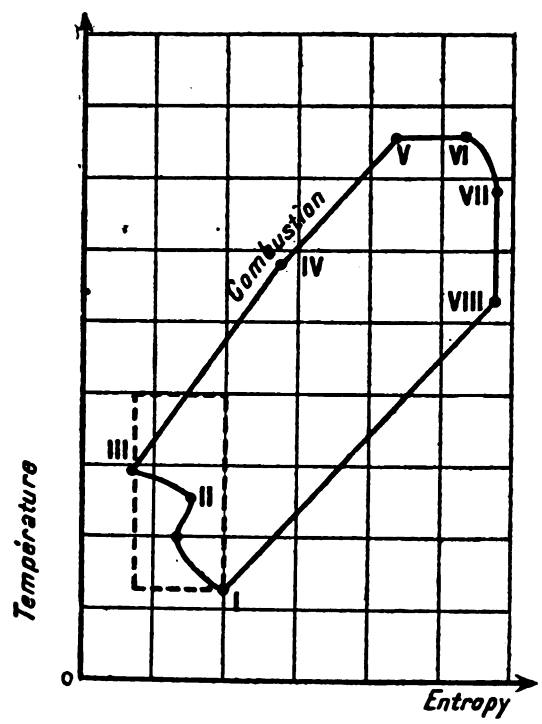
Without discussing here the consequences of Diesel's confusion between a real cycle completed by a given weight of thermodynamic fluids in evolution, on the one hand, and an irreversible transformation applied to two distinct masses united only during a part of the evolution, on the other hand, it will easily be perceived that it is in practice impossible to obtain a Carnot cycle with the efficiencies desired by the inventor (viz., from 70 to 72 per cent) and consequently with the differences of temperature and pressure entailed thereby.

The "adiabatic" expansion and compression are, in fact, pure theoretical considerations, analagous to the idea of indeformable solids or perfect fluids. It is impossible to prevent losses by convection, and above all by radiation between an incandescent gas, and the metallic walls surrounding it, inasmuch as it is imperative to limit the temperature of the walls, or otherwise face insuperable mechanical difficulties. Whether one wish it or not, a considerable percentage of the heat released at high temperature must pass through the walls of the cylinder. In other words, even if one may assume absolute pressure tightness, one must necessarily admit heat losses that are increasingly large in proportion to the rise of the temperature. Furthermore, and again to avoid insuperable mechanical difficulties, one must accept an incomplete expansion of the gases, and as a consequence considerably reduce the curve of adiabatic expansion, replacing it by a curve of constant volume. Yet even with these qualifications, a cycle of combustion at constant temperature would still be beyond reach.

As a matter of fact, if one assumes, with R. Diesel, that the initial compression is carried to 800 degree C. (1450 degrees F.); that is to say, to more than 80 kilogrammes per square centimeter (about 1200 lbs. per sq. in.) the rate of combustion (or the reaction) of the fuel injected cannot be controlled in such a manner that the combustion is not noticeably accelerated; the studies made by Messrs. Jouguet, Decheur and Crussard of the dynamics of explosive mixtures prove this to us, if it were necessary. Thus to sum up, while R. Diesel dreamed of a cycle such as that represented by dotted lines in figure 1, actual facts only permit such diagrams as are represented by the outlines II, III, IV, V, VI, VII, VIII; that is to say, diagrams in which the combustion causes a considerable rise in temperature from 580 to 1500 degrees C. or from 1150 to 2700 degrees F. in which the compression I, II, III sets strongly towards an isothermal near the end of the stroke, and in which the expansion can only be continued to VIII, the gases being discharged at a temperature widely different from the surrounding temperature, and exceeding 600 degrees C. (1100 degrees F.) on an average.

One need not be concerned any further with this impossibility of obtaining a Carnot cycle; but one must, on the other hand, pay justice to R. Diesel for not having obstinately continued upon this wrong path. In reality (and thanks to the material assistance supplied him by the Maschinenfabrik Augsburg and the Krupp Company), Diesel, in the course of his long experiments, gradually adapted his original conceptions, which were a little too academic, to the sphere of possibilities, and was finally contented with a heat engine, in which the ignition of the fuel was produced by the high temperature of the air into which it was injected at the end of the compression stroke. The new principle of the production of energy was reduced to a process of igniton which was still novel, and particularly advantageous.

It would be unjust to gainsay the increase in thermal efficiency due to the raising the compression as compared with the ordinary gas or oil engines (namely, from 6 or at most 13 kilograms to 30 and 35 kilograms which in pound measure means from 90 or at most 190 lbs. to 450 and 525 lbs.); but high pressures are so little to be desired from the mechanical point of view, that many inventors have applied themselves to the reduction of the compression necessary for ignition, thus adopting a course absolutely opposed to that inaugurated by R. Diesel. From these investigations and studies have resulted the semi-Diesel (surface-ignition) engines, which are in high favor for low power requirements.



There is no question that high compressions inevitably entail an important reduction of mechanical efficiency. This fact is the inherent consequence of the lateral friction of the piston, which lubrication cannot reduce like in the main bearings of connecting rod ends. We trust we shall be excused for dwelling on this point in order to show it is wrong to separate—even but roughly and briefly—the thermodynamic efficiency from the mechanical efficiency. Physical conceptions or mechanical conceptions are indeed without industrial value and worth, if they systematically disregard the properties of the materials or parts placed at the disposal of the constructor or builder.

A main working-piston is a mechanical device, which is very much more complicated than the simple, sliding barrel to which it is compared by the Professor, who is concerned only with thermodynamic theorems. For instance, it can only be rendered tight against the high pressures used in our slow-combustion engines by supplying it with a series of sprung rings properly machined and ground, whilst itself is fitted in the main cylinder with relatively considerable clearance, in such manner as to assure its freedom even when the heat of combustion has subjected it to the maximum expansion and distortion.

It results herefrom that the piston is under gas pressure not only on the head, but also on its cylindrical walls, as far as the edge of the last ring. Certainly these lateral pressures are not as great as the motive pressure, but they necessarily exist, and are only equal around the entire circumference if the piston has accurately centered. As this is never true of a trunk piston—which is the type most commonly employed in slow-combustion engines of average power—it follows that in general a considerable force acting perpendicularly to the axis tends to increase the lateral reaction on the side already subjected to the force due to the obliquity of the connecting-rod, and at the same time makes the piston assume a diagonal position in the cylinder, similar to a slide valve which is too short and poorly guided. The friction caused hereby is naturally very high, especially in the neighborhood of the dead center at the end of the compression stroke, and there follows a reduction of mechanical efficiency which is just so much more marked, the higher the maximum pressures of the cycle have been chosen.

This is but one example of the mechanical difficulties that had to be surmounted in the construction of slow-combustion engines. In fact, it may be said that it was not the realization of the new cycle or, to speak more correctly, the solution of the questions raised by the injection under pressure of fuel in a working cylinder which caused the longest delays in the development; but, on the contrary, it has been the mechanical consequences of the use of high compressions which have retarded, for more than fifteen years, the practical application of the first invention of Rudolph Diesel. Even today in certain slow-combustion engines, when the internal stresses and the selection of materials have not been studied with care, the breakage of working parts in regular service is sometimes encountered.

Diesel engines are not mediocre, neither in the study of the design of the parts subjected to the working or to the direct heat of the flame, nor in the production which, for certain parts, such as the main pistons, the injection valve, the valve cams, the fuel pumps, requires an accuracy far greater than that which the regular engineering shops are accustomed to consider adequate. It is necessary, therefore, in order to introduce the new industry in an existing ship, to modify to a great extent the spirit and practices of the drafting room and of the production department. Those are not the least of the difficulties.

The limited space allowed us prevents our giving in detail the results obtained today by various French and foreign firms in the construction of stationary, horizontal or vertical Diesel engines of medium and high power. We simply wish to give an idea of the perfection which has been attained in the last few years in the manufacture of engines of high speed and very high power for the propulsion of submarine craft. We shall take as an example the engines constructed recently by the Schneider Plant (Creusot Works) and placed in commission in a few units of the French submarine fleet. Some developed 1500 B.H.P., and it is probable that still more powerful units will soon be constructed.

These engines, most of which operate on the two-stroke cycle, run up to 400 revolutions per minute, permitting a reduction of the weight per brake horse-power to about 30 kilograms, or 65 lbs., this figure including all accessories and auxiliary devces necessary for the operation and starting of the engine, such as bottles for compressed air, circulating pumps—if they are not actuated by the engine, etc.

They burn scarcely more than 200 grams (0.45 lb.) of fuel per brake horse power hour, viz., about 2000 calories per H.P., while ordinary marine steam engines require at least 5000 to 6000 calories for the same power. There is, thus, an undeniable thermal progress, which will be converted into a positive economic progress in France the day tar-oils and shale-oils (and perhaps the petroleum oils of Algeria) reduce the price of the oil-calory to a figure comparable with that of the coal-calory. Furthermore, even at this present time, the economies which can be effected in the staff of engine-

*We are indebted to Mr. R. W. Crowly for his kind assistance in connection with the translation of Mons. Drosne's article.

room and boiler-room, as well as in various auxiliary services enable freighters with good Diesel engines to operate to advantage on certain routes where they can be sure of finding liquid fuel at fair prices.

To revert to high-speed engines for submarine craft let us remark that they have little resemblance to those to which we have referred in regard to freighters, where the engine speed rarely exceeds 120 revolutions per minute. In the case of the latter, the vertical dimensions of which are not limited, and which may weigh up to 200 kilograms (440 lbs.) per horse-power (as much as the steam installations which they replace), the construction is very much more convenient and, so to speak, classic, for the majority of the important parts are identical with those of the vertical steam engines, which for 40 years have been of almost uniform type for freight vessels. We will refer again later to the Diesel installations for cargo boats.

On the other hand, submarine engines have their transverse dimensions strictly limited by the special requirements of the installation and by the very narrow space left free in the interior of the submarine. They are therefore very stocky and, consequently, single acting, with trunk pistons, which are in most cases devoid of crossheads. It is, however, sometimes possible to arrange guides and crossheads, but a reduction of the ratio of connecting-rod to crank and a shorter stroke with a bigger bore must be allowed for—circumstances which greatly reduce the benefit to be obtained from a guide separate and distinct from the piston.

The crank-case and base-plate are of electric or crucible cast steel, a quality of metal demanded by the extreme reduction of scantlings and by the complicated design of these parts. The cylinder jackets and the heads are also frequently of crucible cast steel.

The crank and cam-shafts are of heat treated, semi-hard steel, and all parts subject to hard wear, such as the cams, cam-rollers, valves, spindles, compressor-valves, etc., are of alloy steel. All parts exposed to the direct heat of the flame, such as the cylinder liners, cylinder covers, exhaust-valve seats and exhaust pipes are water jacketed. In the large two and four-cycle engines, the pistons must be cooled by a circulation of oil or of fresh water. In the slow speed engines of freighters the pistons are cooled by fresh water in a separate closed circuit, and the water is passed through a surface cooler. Very efficient arrangements are provided to avoid absolutely any leakage of water into the oil circuits. In engines, on the other hand, this condition is very difficult to meet, and a circulation of oil is most often employed. The crank pins and the main bearings, the cylinders and the other principal moving parts are lubricated under pressure.

There are, thus, two distinct oil circuits under pressure: one for the piston cooling and connected with the piston by properly arranged sliding joints, and the other for lubrication. However, care has been taken that the same oil can be used for both circuits, so that leakages do not cause any trouble in operation and do not entail any other inconvenience than that of filling, from time to time, to the proper level in the supply tanks. One may at first be surprised at the employment of oil as a cooling medium, remembering the viscosity of this substance and its very low specific heat. But in the case which we are considerng, the average temperature of the oil in the main pistons amounts to 80 degrees C. (175 degrees F.), and its viscosity is then lower than that of water, which together with a turbulent flow considerably increases its cooling power. Since the flash-point and the boiling-point of the oil chosen after very long investigation for marine engines are considerably higher than 80 degrees C., it can be stated that there is no inconvenience in using the method we have just indicated for piston cooling. However, it is obviously simpler to use water, but one can only do so safely if arrangements have been made to avoid absolutely any leakage into the crankpit. It appears, furthermore, very probable that the new arrangements will make it possible in the near future to carry this plan into effect. It is unfortunately impossible for us to describe these arrangements in detail, despite the interest they offer.

The valve arrangement of submarine engines deserves special mention. In the first place it is clear that the fuel pumps and injection valves are fundamental working parts of the engine. The first-named must be measuring devices of extreme dependability and accuracy, otherwise unacceptably high pressures will be created by excess of fuel, or, as more generally happens, inequalities of power will prevail, liable to interfere with the operation of the engine, and to break down certain working parts, such as the shaft, which is always very subject to torsional vibrations. The device invented by R. Diesel's assistant (M. Reichenbein) has hitherto been faithfully adhered to, for it provides in a very simple and positive manner a type of pump with constant stroke and variable supply.

The purpose of the injection-valves is to introduce into the main cylinder a flow of oil, properly broken up and properly distributed throughout the mass of air compressed between the piston and cylinder head. In general, compressed-air is required to give the necessary power for injection and pulverization.

The operation of this working part has not as yet been studied by direct observation, and it is only by the color of the exhaust and the shape of the diagrams that one can tell whether the nozzle properly fulfills its duty. It would appear that the Schneider marine engines afford in this connection a satisfactory solution of the problem, for complete combustion therein is assured even at the highest powers, and the slight traces of soot visible on the cost walls of the pistons and heads give a true picture of the proper diffusion of the blasts.

The operating mechanism for the various valves (scavenging-injection-starting) is pretty diversified among the different builders, who have striven, along the lines of their personal ideas, or their former customs, to apply every manner of mechanical combination permitted by stationary or sliding cams, variable-throw eccentrics, rolling levers, etc. Even systems of operation by oil pressure, of the Bachrich or Bonjour type, have been tried. It is difficult to attribute any marked superiority to any one of these combinations.

The system that gives full satisfaction in the Schneider engines has the merit of relative simplicity. The valves are all controlled by a longitudinal cam shaft, capable of a certain displacement in the line of its axis, to permit the substitution of the astern cams for the ahead cams, or vice versa. Furthermore, another longitudinal cam shaft, called the control shaft and moved by hand, serves to produce the necessary stages of starting, which as as follows:

1. Release from a certain number of cylinders which are on compressed air the starting air that is playing the role of the injected fuel. This requires the operation of the starting valves and scavenging valves.

2. Progressive substitution, that is to say, cylinder by cylinder, of fuel in place of starting air, in such manner as always to maintain a sufficient torque even in case of the firing being delayed one revolution (this requires the cutting-out of the starting valves and the interposition of the cam-rollers of the injection needles).

The mechanical control of the operating shaft is carried out in such a manner that the engineer need only continue to turn a crank in order to produce in proper sequence and without trouble from overlapping, the successive stages specified above. The starting is thus effected with an ease that is actually comparable with that of multi-crank steam engines and without any need for uncoupling between the engine and the shaft line. The couplings can therefore be of a positive type without any inconvenience.

The consumption of compressed-air is, moreover, very low. Very often, even, it is nil, for the engine fires so quickly that the few revolutions it makes on oil at the time of manoeuvering, suffice to make up by the aid of the air-compressor for the consumption due to the first phase of the starting.

The scavenging pumps of submarine engines can be driven either directly by the main shaft, or independently, or jointly; that is to say, formed by the parallel coupling of the engine-driven and of the independent pumps. This last arrangement offers special advantages, for it permits the pumps driven by the engine to be proportioned in such a way that they suffice for cruising speed, as for instance, half power and, consequently, half of the volume of air admitted for full power, the further supply to be furnished by the independent pumps, which are electrically driven at high speed, this leading to a great reduction of the space they occupy.

On the other hand, it appears preferable to maintain the direct drive on the blast compressor, for it is not desirable to speed up this apparatus, the automatic valves of which adapt themselves poorly to speeds higher than 400 revolutions per minute.

And since we have mentioned blast-compressors, may we by way of information call attention to them, and in particular to their valves, which have often been the cause of serious breakdown in high speed engines and which have thus contributed greatly to the difficulties of the industrial adaptation of the Diesel engine. We find here again one of those mechanical problems which are so common, which many have believed completely solved, and which, as a matter of fact, have only been so after deep study and arduous experiments.

Before the appearance of the Diesel engine, the high-pressure, high-speed compressors existed only for charging of torpedoes, a type of apparatus with a very short period of operation. Actual practice soon showed that the period of continuous operation has a direct influence on the life of the valve springs, and that the equalized operation of the various stages of the compressor is intimately connected with the way in which the valves are returned to their seats at the end of each pressure-stroke. Although in the case of water pumps the motion of the valves—opening or closing—takes place during periods in which the piston speed is practically nil, this is not true of compressors, the valves of which, in order not to be subject to destructive hammering, must be very light and returned both with sufficient strength to effect an almost instantaneous closure as well as softly enough to meet the seat without injury. If one add hereto that they are in an atmosphere of very high temperature, capable of causing appreciable distortion of the seats and in every case of altering the mechanical properties of certain steels, one can understand the magnitude of the difficulties which the builders had to surmount. These have sometimes been sufficiently great to lead builders towards new injection devices, such as solid-injection, or automatic-injection. They can, however, be overcome, but only after a minute study of the laws governing the operation of free valves and after a suitable selection of materials.

The study of the movements of automatic valves alone whether by calculation, or by indicator tests is itself one of the most arduous of tasks for the engineer, obliged most frequently, as he is, either to interpret results that are not very accurate or are merely qualitative and to help out with more or less justifiable hypotheses of a simplifying character, or else become involved in a labyrinth of inextricable calculations. And yet such problems cannot be solved solely by what is termed "practice," which is too often the brutal confirmation of accidents or fracture of parts.

It is therefore, absolutely necessary to analyze, but it is also necessary that this analysis be given sufficiently elastic, so that, when observed facts are used as a basis, only a relatively simple mathematical treatment is necessary, which is within reach of those called upon to interpret the results. We are tempted to be of the opinion of the British engineer who only accepted formulas that were less than an inch long.

However that may be, the large majority of constructors have found it possible to develop the compressors, and as far as the Schneider Works are concerned, they continue to employ in their engines the system of compressed-air injection, which because it produces a far superior pulverization to that of the simple pressure injection, enables one to obtain the consumption per H. P. indicated at the beginning of this article. We should have liked to show the fundamental part played by pulverization in the speed of combustion and consequently in its greater or lesser degree of completeness. But this would entail at least as long a dissertation as the one to which we have referred in regard to compressor valves. We will therefore not include it in this brief, general summary, but we hope some day to be able to devote a few pages to it.

We will, in conclusion, say a few words in regard to Schneider engines intended for the propulsion of freight vessels. The builder has naturally made use of extra weight allowed him and strengthened to the limit all the parts subjected to the internal stresses credited during the period of combustion. He has preferred to increase the engine speed considerably as compared with the standard steam type in order to take the fullest advantage of the strengthening thus permitted.

These engines can thus work up to 140 revolutions per minute in normal operation, and a single cylinder can develop at this rate 300 to 400 shaft-horse-power with a very low mean-effective-pressure, so that sets of 1600 to 2499 B.H.P. can be obtained with 4 to 6 cylinders. They operate on the two-stroke cycle, the scavenging-pumps being actuated by walking beams connected with the piston-rods of the two center cylinders. [The above means twin-screw six-cylinder sets of 7,500 B.H.P.—Editor.]

The scavenging-air is admitted by valves driven by a series of levers and cams, arranged in such a way that a single cam can actuate at least two valves. The valve arrangement is very similar in principle to the one described above for submarine engines, but it is designed very much more generously to assure it indefinite wear.

The piston-rods are guided by crossheads, a style of construction which in this special case possesses very much more marked advantage than in submarine engines, because the increase in engine height caused hereby does not present any

disadvantageous feature and does not necessitate any reduction in the length of piston, nor in the ratio of connection-rod to crank. It is important moreover to make the general operation independent of the wear of the rubbing surfaces, and this can only be done if easy means of adjustment are provided for most of them. As a piston cannot easily be provided with means of taking up wear, it is absolutely necessary to make provision on the guides. Finally, the satisfactory operation of the engine in case of permanent list or prolonged roll likewise remands the provision of a slide and guides.

Beginning with the connecting rod small-ends, the moving parts of the engine offer the greatest similarity with an ordinary steam engine. However, the speed of 140 r.p.m. which is relatively high, had led to a lubricating device, somewhat out of the ordinary. Without constituting so to speak, forced lubrication, that is to say, under a pressure of 7 to 30 lbs. per sq. in., the lubrication is assured by an abundant flow of oil, conducted to the main bearings by a gravity tank, than to the big-ends and small-ends through drilled channels. Steel sheets that do not form an entirely closed casing, collect the splash and lead it to one of the oil tight pans, fixed to the foundation plates and independent of the steel sheets. Only the level of the oil tank has to be attended to and it is fed constantly by a pump drawing the oil from the bottom of the pans to which we have just referred. Sight-feed devices on each main bearing moreover permit this supply to be watched.

Such an arrangement pre-supposes that sea-water is never resorted to for hot-bearings or at least employed only in case of absolute necessity, for it is evident that the emulsified oil and water cause troublesome rust in the channels which it would pass through. But, practice has shown in the large stationary gas-engines that a lubricating system of the character just described offers the best guarantees, superior even to those of forced lubrication, for it is not exposed to the breakage of the pressure pipes.

A clutch between the engine and the wheel is not essential. In fact, the maneuvering control which we have briefly described permits the machine to be started up when the surrounding temperature is not below 40 degrees F. In cold weather, it is necessary to use various means for facilitating the flow of fuel and for raising the temperature of the main cylinder walls. As there is always an auxiliary boiler on board, for the deck winches, windlass, etc., it is the simplest matter in the world to obtain the necessary heat from the steam.

It goes without saying that the Diesel engines of freighters are equipped to burn what is conveniently termed fuel-oil, that is to say residual-oil, or tar-oil or the residues of shale-oil distillation. But, it is fair to add that all the arrangements used to attain this purpose are not equally satisfactory, and this may be attributed more or less to the care with which the builders have studied the question of combustion under pressure.

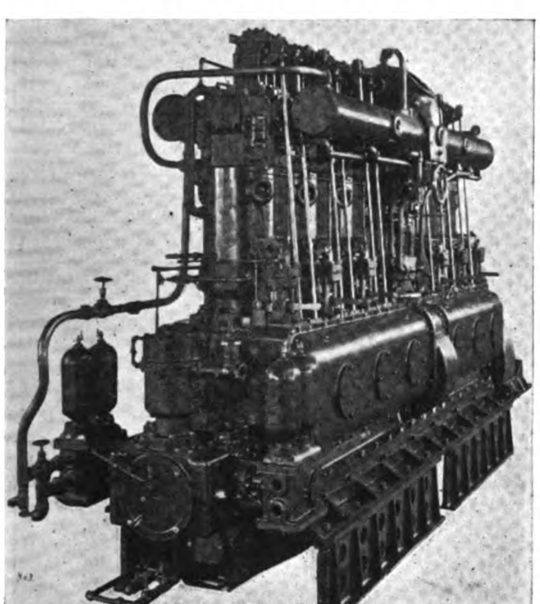
It may appear sufficient to mix a little ordinary kerosene with heavy-oil, or to inject this kerosene simultaneously with the fuel-oil into the main cylinder to induce combustion. It is true that acceptable results are thus obtained, but they are always a little unreliable and very often produce irremediable knocks on the main pistons.

It is necessary to state that the mechanics of combustion, to which we allude above in connection with pulverization have only been known a short time with sufficient accuracy to make it possible to work efficiently on the problem. Particularly would it be entirely wrong to establish any comparison between combustion of a mixture of air and gas in an explosion engine, and the flame formed by the mixture having the injection nozzle. This is a real flame arising at a certain distance from the nozzle, in a region where the velocities of the mixed current are sufficiently retarded to be equal to the speed of propagation of the flame in the mixture of air and atomized oil; this speed of propagation of the flame is thus found to be characteristic of the combustion and is a function principally of the heat conductivity of the mixture. On the other hand, the temperature at the beginning of combustion or the temperature of ignition has no relation with the volatile contents of the oil. As a result, the question of the use of heavy oils in Diesel engines must not be considered as solved simply by instructions applicable to all cases. Each fuel requires a special arrangement of the injection needle, and sometimes even a considerable pre-heating. It is, however, evident that the progress to be made in this direction will be extremely useful, for it will correspondingly increase the number of cases where propulsion by the Diesel engines is truly advantageous.

Price-Rathbun Oil-Engines for China

For the purpose of installation in two 2,500 tons d.w.c. wooden schooners, there recently has been shipped to Brossard Mopin & Co., Tientsin, China, four 240 Price-Rathbun marine heavy-oil engines. These motors were constructed at the Rathbun Jones Engineering Co.'s works in Toledo, Ohio, and while their standard practice as to design was quite closely followed, they were able to use but little of their stationary-engine material. From the time the first engine turned over, until the acceptance test on the last unit was run, was but 84 days—which seems to be an excellent showing.

The illustration on this page shows the general features quite plainly. The reversing of the motion is accomplished by reversing the functions of



The 240 h.p. P. R. marine oil-engine

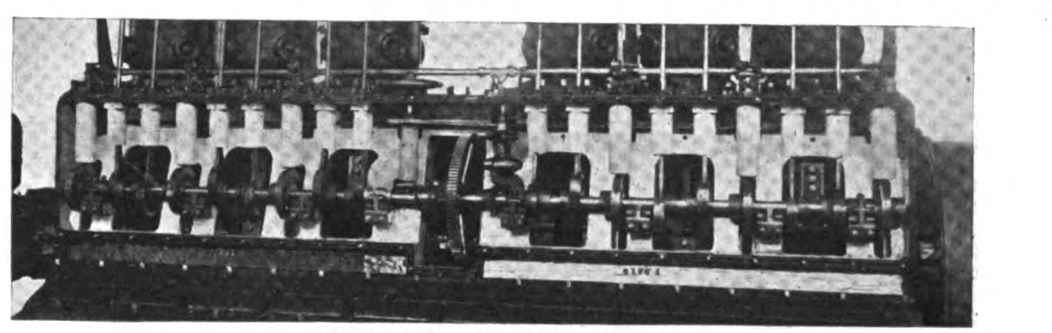
the exhaust and admission valves—these valves, as well as the fuel cams, being so set that the engine runs in either direction and so only requires the proper application of the compressed-air without disturbing the principal valve-mechanism. The horizontal hand-wheel on top of the housing is driven by a "stop" and carries a single cam, which engages the various air-valves in the proper order. With this hand-wheel against the "stop" in one direction the engine is started ahead; when moved about 30 degrees against the "stop" in the other direction, the engine then reverses its motion.

A pair of cross-over valves operated by the upper hand-wheel allows the manifold, which may at the time be exhausting, to connect with the exhaust pipe. An arrangement of two separate pipes to the outside would do away with this feature of the cross-over valves and will probably be followed in future designs.

The main oil filter is seen mounted on the upper part of the engine and from which the oil flows to small filters at the fuel-injection pumps which are mounted on the housing. Each pump supplies two nozzles mounted on opposite sides of each combustion-chamber. Each nozzle also has a small filter mounted within it.

Starting when cold is readily accomplished by means of a simple hot-wire type of igniter, which after a few moments may be disconnected and after which ignition is automatic. A double-shoe Kingsbury thrust-block is fitted. The crank-shaft is in two three-throw sections that are alike.

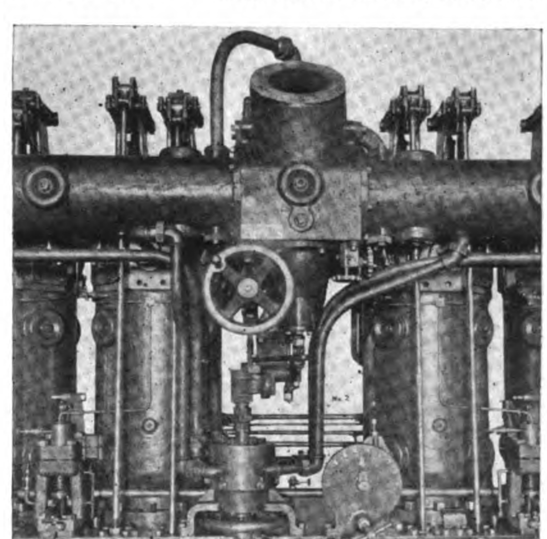
The average result obtained from the four engines on their official tests was 0.435 lb. of fuel-oil per b.h.p. hour. These particular machines are



View showing camshaft uncovered

rated 240 h.p. at 235 r.p.m. and have cylinders 13-in. diameter by 17-in. stroke.

The P-R Oil Engine is now being marketed by the Ingersoll-Rand Company, 11 Broadway, New York, who have acquired the selling rights. For the present it is offered in sizes from 200 to 600 shaft-horse-power. Other sizes are being developed.



The P. R. control and valve mechanism

MR. D. H. COX LEAVES THE EMERGENCY FLEET CORPORATION

Mr. Daniel H. Cox, having resigned his position as Manager, Ship Construction Division, U. S. Shipping Board, Emergency Fleet Corporation, has resumed his original business with the firm of Cox & Stevens, Naval Architects, Marine Engineers and Vessel Brokers, 15 William Street, New York City.

WERKSPOOR RECEIVES ORDERS FOR ANOTHER MOTORSHIP

Messrs. Winge & Co. of Christiania, Nerway, have placed another order with the Werkspoor Engineering Works of Amsterdam, Holland, for a large ocean-going motorship, which will be fitted with two Werkspoor-Diesel engines aggregating 4,400 I.H.P. This new vessel will be a sister ship to the "Geisha" and "Tosca"—two motorships now building at the same yard for these Norwegian shipowners.

FLEET OF DUTCH MOTOR AUXILIARIES

One firm of shipowners in Holland are having built 20 oil-engined steel auxiliaries of 900 tons d.w.c. each, for service between Great Britain and their own country. The first of these vessels—the "Alberta"—recently reached South Shields, England, on her maiden voyage. But the "Alberta" is ony of 700 tons d.w.c. so is a little smaller than the others of the fleet. A report reaches us that there already are over 500 motor-schooners in the Netherlands.

ROYAL DUTCH OIL PRODUCTION

In 1918, the crude-oil production of the Royal Dutch Petroleum Co. and its associated concerns, was 28,000,000 barrels, excluding any Russian production.

PROFITS OF THE REDERIAKTIEBOLAGET TRANSATLANTIC

In 1918 a profit of 9,510,000 Kr. was made by the Rederiaktiebolaget Transatlantic of Stockholm, Sweden, who are the owners of the 9,500 tons motorships, "Bullaren" and "Tisnaren." Their total fleet today aggregates 147,100 tons d.w.c. Their ships of their subsidiary companies total 53,375 tons d.w.c. and together made a profit of 5,779,350 Kr.

The Diesel Engine Heat-Cycle and a Survey of the Range of Theoretical Cycles Possible in Heat Engines

By R. D. KARR, Assoc. Mem. Am. Soc. N. A. & M. E.

THOUGH the details of the operation in both the two and four-cycle engines working on either the Otto or Diesel principle are known to all, the question as to the suitability of one over the other in the heavy-oil engine field is still a mooted one. The explosive combustion of fuel in an Otto engine results in pressures and temperatures greatly in excess of those resulting from compression, and these extremes occur at very nearly top centre. The slow sustained combustion in the Diesel cycle produces temperatures less severe than the former and pressures slightly in excess of those of compression which is maintained nearly constant for about ten per cent of the stroke.

In discussing heat cycles, "of internal combustion engines," the following line of reasoning regarding this question suggested itself several years ago, and with some recent modifications is as follows: The formula for engine-efficiency may be expressed in terms of either the temperatures, pressures, or volumes between which the working medium operates. They are:

$$\text{I} \quad E = \frac{T - T_1}{T}$$

where T and T are the initial and final absolute temperatures respectively, or

$$\text{II} \quad E = \frac{P_1^{\frac{n-1}{n}} - P^{\frac{n-1}{n}}}{P^{\frac{n-1}{n}}}$$

$$\text{III} \quad E = \frac{V^{n-1} - V_1^{n-1}}{V^{n-1}}$$

where PV and P.V. are the initial and final pressures and volumes respectively, and n is the exponent in PV^n = a constant.

Now considering the ideal cycle of any heat engine it will be seen upon inspection of the three formula, given above that heat may theoretically be added and subtracted during the cycle under numerous conditions of constant and variable pressure, temperature or volume. In all cases for a specific cycle there must be a limit upon at least one of the functions of the working medium during the introduction of heat:—either of maximum pressure allowable, · maximum temperature or minimum volume. Also at the end of the working stroke or power delivering period there must be a limit of minimum pressure or temperature or maximum volume at which the working medium for the cycle can operate.

The following is a list of the total variety of combinations of the various function limits where heat is received and expelled under constant conditions.

TABLE A

Heat added and subtracted at constant maximum and minimum limits.

Type	Heat added at Constant	Heat substracted at Constant.
A1	Pressure	Pressure
B1	Pressure	Volume
C1	Pressure	Temperature
D1	Volume	Volume
E1	Volume	Pressure
F1	Volume	Temperature
G1	Temperature	Temperature
H1	Temperature	Pressure
K1	Temperature	Volume

Each of the above "types" of cycles has nine variations in possible operation by removing the restriction of having the limit placed upon the same function which remains constant at both addition and subtraction of heat. For example, in type A cycle heat may be added at constant pressure, but the construction or design of the engine or for any cause the working medium is to be limited as to the maximum temperature, pressure or minimum volume to obtain during such addition of heat. Similarly during the expulsion of heat at constant pressures—the maximum volume or minimum temperature or pressure may be the governing factor in the working of the cycle. The arithmetical possibilities then for each type of cycle are the same, the following list being those for type A.

TABLE B—TYPE A

Limit on one function, with a second remaining constant.

Cycle	Heat Added Under Constant	Function Limited	Heat Subtracted under Constant	Function Limited
A1	Pressure	Pressure	Pressure	Pressure
A2	Pressure	Temperature	Pressure	Pressure
A3	Pressure	Volume	Pressure	Pressure
A4	Pressure	Pressure	Pressure	Temperature
A5	Pressure	Temperature	Pressure	Volume
A6	Pressure	Volume	Pressure	Temperature
A7	Pressure	Pressure	Pressure	Volume
A8	Pressure	Temperature	Pressure	Temperature
A9	Pressure	Volume	Pressure	Volume

There are, therefore, eighty-one separate and distinct theoretical possibilities in cycles with the addition and subtraction of heat carried on under *constant* conditions of a particular function. Now if we take away this restriction so that the addition or subtraction of heat or both may be made under variable conditions of the function heretofore held constant, each cycle in table B may have a further variation of four sub-divisions as shown in the following table:

TABLE C

Limit on one function, while it or any other function may be either variable or constant during either the addition or subtraction of heat or both.

Cycle	Heat Added Under	Function Limited.	Heat Subtracted Under	Function Limited
A1-a	Constant Pressure	Pressure	Constant Pressure	Pressure
A1-b	Variable Pressure	Pressure	Variable Pressure	Pressure
A1-c	Variable Pressure	Pressure	Constant Pressure	Pressure
A1-d	Constant Pressure	Pressure	Variable Pressure	Pressure

Thus there are four subdivisions of each of the eighty-one cycles or a grand total of three hundred and twenty-four minute variations of heat cycles in general.

Naturally after bringing all these combinations to the attention of the patient reader it is in order to inquire into the possibility of speedily eliminating the majority of them as inapplicable for practical operation or as fundamentally not efficient. So in the first place a general inspection of the three formula 1, II and III for cycle efficiency under any conditions will show that the greater the difference between the first and second terms of the numerator the larger the value of the fraction and hence of E. Differentiating each equation we have for the efficiency of a small heat increment:

$$E = \frac{dT - dT_1}{dT} \quad \frac{dP^{\frac{n-1}{n}} - dP_1^{\frac{n-1}{n}}}{dP^{\frac{n-1}{n}}} \quad \text{or}$$

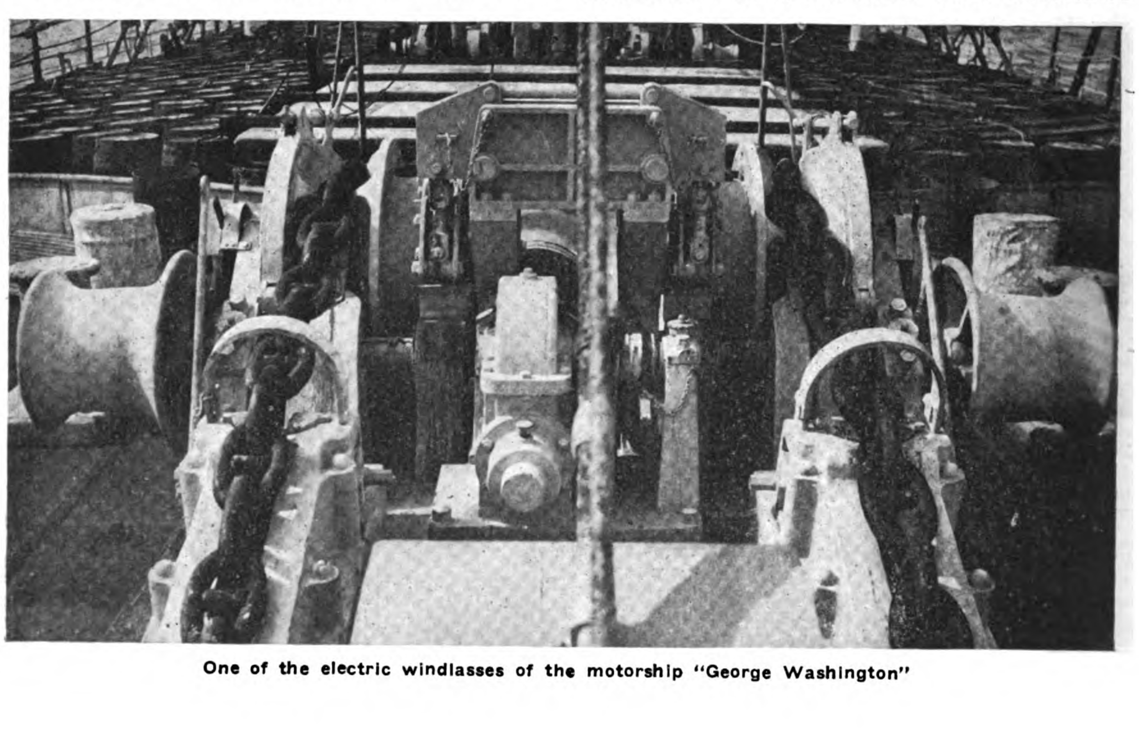
$$\frac{dV_1^{n-1} - dV^{n-1}}{dV_1^{n-1}}$$

Thus we see the same holds true regarding the maintainance of a maximum value for the first term and a minimum value for the second term of the numerator to insure the highest value for the efficiency of each increment.

With specified limits, this therefore means the introduction and expulsion of all heat at such limits and we are able to eliminate immediately the last three cycles indicated in table C and all similar ones or the pleasing number of two hundred and forty-three (3 times 81). Mention may be made, however, of the fact that in any practical attempt to operate under *constant* conditions of any function the actual result will undoubtedly fall into the class we have just rejected, as being theoretically the less efficient. For instance the only really practically obtainable cycle n endeavoring to obtain addition and subtracton of heat under constant pressure would beyond doubt result in cycle A1-b see table C. And similarly for the other functions the results would be cycle D1-b and G1-b.

Further, in referring to table B it is noted that in this class of cycles heat is added and subtracted with a certain function constant, while the limit being placed upon another function precludes satisfactory results for this reason: with one function constant, heat cannot be introduced or taken away from a gas without producing a change in both the other functions unless the mass or quantity of the gas also be changed. Therefore in eight of the nine cycles in each type as shown in table B, that function which bears the burden of a given *limit* must vary during the interchange of heat. This is contrary to our already established rule that any limit when imposed upon a function for the introduction or expulsion of heat should be attained and adhered to for best results. This finding takes eight cycles from each group similar to that in table B, leaving but the nine types originally listed in table A. Thus we have reduced the number of cycles for further analysis to nine, wherein all the transference of heat occurs at a constantly maintained limit of the function designated as governing the working of the cycle.

For further reduction our interest will be to determine if it should not be the same function that should be limited at both the receiving and giving off of the heat. This is best illustrated by the PV diagram as sketched in figure III. Inspection of this figure shows for example—upon the extraction of the decrement, i. e., that particle heat which can be assumed as having the expansion line r r' had a higher ratio of expansion than did the heat added from x to b and subtracted from C to x. This sketch it may be noted serves to illustrate the PV diagrams of several cycles in table A as follows: Fig. a b d e illustrates type A1 cycle or combustion and exhaust both at constant pressure. Fig. a b c e illustrates type B1 cycle. Fig. f b c e, type D1 cycle; and Fig. f b d e, type E cycle. It is evident that if all the heat introduced along the line "a b" could all be extracted at the same pressure as that from v to e, the useful work represented



One of the electric windlasses of the motorship "George Washington"

by area c d e would be a distinct gain. Thus our final condition for the theoretically most efficient cycles are that both constant addition and subtraction of heat be employed and that it be the same function that remains constant during such addition and subtracton. Upon inspection of table A again we find cycles A1, D1, and G1 alone fulfill these conditions.

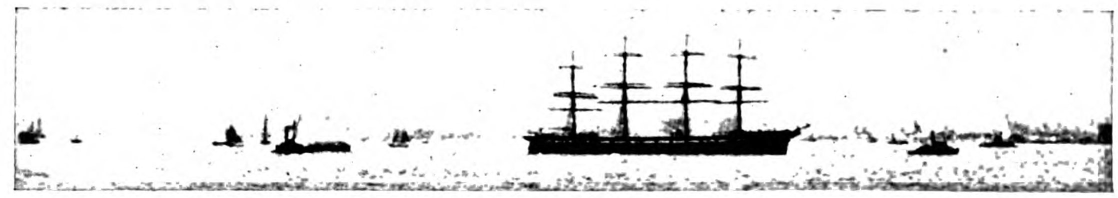
Of the three, D1 is the only cycle that has a mechanical counterpart in internal combustion engines, and that mechanical cycle is the true Otto explosion type. Type A1 has a partial likeness in the Diesel engine in that combustion in this design is approximately at constant pressure. The exhaust, however, is quite similar to that of the Otto engine and is thus at practically constant volume. This change in limit from one of pressure to one of volume we have seen is not ideal, but practical conditions confront us and the compromise in the present operation of the Diesel engine in a close mechanical fulfillment of the cycle B1.

The third type of cycle G1 presents an interesting problem, but with the mechanical means of converting heat into work with a gaseous working medium in use at present this cycle has no mechanical equivalent. Dr. Diesel first planned to operate the injection of fuel in his original engine to obtain combustion at constant-temperature, but but soon gave it up and adopted the manner which it was possible to achieve mechanically with more exactness.

I have indicated that the Otto cycle is practically a mechanical fulfillment of the "constant volume" cycle D1. Then it is evident that when practice achieves the theoretical so precisely, nothing more could be wished. However, it has also been demonstrated roughly in the foregoing analysis that when one limit of an engine cycle is fixed, the other limit should also be fixed upon the same function (temperature, pressure or volume) of the working medium. Such a condition exists in all internal combustion engines working on air and oil—for expansion cannot go below the pressure of the atmosphere.

Therefore the introduction of heat, or combustion, should occur at a constant pressure as great in excess of the atmospheric pressure as possible. This the Diesel engine accomplishes and therein lies its practical economy even though its cyclic counterpart is not among the select few.

In conclusion, there seems to be a large field for mathematical and practical research in the field of heat cycles. It is suggested that the nine in table A are all that should be considered in regard to the possibilities of obtaining their conditions mechanically. Also if investigation were entered upon it would be best to bear fully in mind the expression to be found in Guldner to the effect that the art of internal-combustion engines is sadly in need of more rational design and less invention. Perhaps, however, there is another mode or medium for heat transference into work which would make possible a more accurate adherence mechanically to a theoretical cycle. Even one which our foregoing reasoning has shown to be less efficient might result in better performance than the 35 to 40% of the heat equivalent now realized in work done with the Diesel engine, simply by a complete transformation of all the attainable heat units from that cycle. Even as Dr. Diesel abandoned his early efforts for combustion at constant temperature to that at constant pressure, because the latter was more readily and precisely realized in practice.



A frequent sight in New York Harbor—a sailing-ship without auxiliary power being towed out to sea. There is another tug on her port side. The Editor of "Motorship" personally made this photograph a few weeks ago to demonstrate the great waste of men and coal through no oil-engine being installed in the sailing-vessel

ITALIAN SAILING-VESSELS AND MOTOR POWER

Our own Federal shipping officials can with advantage follow a rule adopted in Italy. No Italian sailing-vessel is allowed to engage in the Atlantic trade without auxiliary oil-engine power sufficient to give reasonable speed when the sails are not in use.

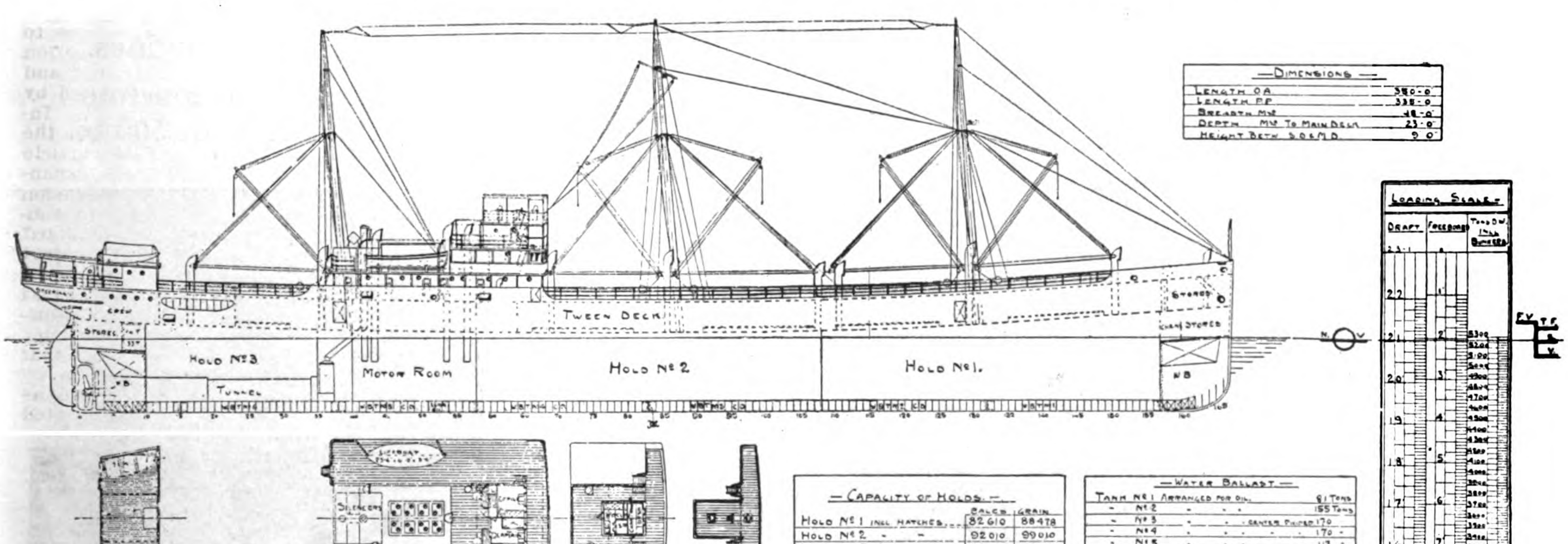
This, by the way, in one instance had an unfortunate result, brought about by war conditions. The owners of a thirty-year-old sailing-vessel of 2,700 deadweight capacity were anxious to send the vessel to America on short notice, and the only engine which they could obtain quickly was a six-cylinder two-cycle type submarine engine of 1,200 to 1,500 b.h.p. designed to run at about 400 r.p.m. This engine was installed and reduced the rating and speed to 145 r.p.m., at which 550 b.h.p. is developed.

The engine, which was entirely unsuitable for the purpose, was installed in a very small space, so that it was impossible for the engineers to attend to it. Consequently, not a little trouble resulted, and the vessel took about 40 days to reached the United States, although before the engine trouble developed, the ship made 1,700 miles in seven days.

VICKERS, LTD., & PETTERS, LTD., COMBINE

Vickers, Ltd., of Barrow, and Petters, Ltd., of Yeovil (England), have entered into an arrangement to combine in the construction and marketing of the Petter marine and stationary surface-ignition heavy-oil engines. A subsidiary company is being formed with a capital of $2,500,000.00, and will start with $500,000.00 cash in hand. Vickers and Petters will be the sole shareholders. They are taking on for the purpose, the large works at Ipswich erected about six years ago by the Consolidated Diesel Engine Manufacturers, Ltd., and which Vickers, Ltd., purchased early in the war for building submarine Diesel engines.

Messrs. Vickers, Ltd., contribute the freehold works at Ipswich with all equipment and stock, while Messrs. Petters are transferring to the new company all patterns, drawings, designs, jigs, and special tools at present used or intended for the construction of the Petter semi-Diesel oil-engine, together with all the stock on hand and work in progress which has not reached the erecting stage, and including the relative patents, designs, goodwill, and orders in hand at March 31, 1919. Mr. Ernest W. Petter will be Managing Director for the coming five years.



Plans of the motorship "Bayard," sister vessel to the m.s. "Borgland," described on page 39 of "Motorship" for February, 1919. She is of 5,300 tons d.w.c. and of 2,000 I.H.P. Trial speed, 11.75 knots. Owner, Fred Olsen, Christiania, Norway. Capacity of hold, 303,419 bales, or 327,279 cub. feet of grain. Length O. A., 350 ft. Length B. P., 335 ft. Breadth, 48 ft. Depth, 23 ft. Classed to Norwegian Veritas.

The Pittsburgh Marine-Oil Engine

New High-Compression Motor of the Brons Type

DURING the last few years much interest has been displayed by engineers of this country in the type of high-compression oil-engine originally developed in Holland by the Brons Motorenfabrik, of Appingsdammer, but better known in America as the Hvid type motor. So much interest has been aroused that between twelve and twenty domestic companies have taken out manufacturing licenses for marine or stationary sets, or else for both. The marine field for this engine includes power for ship's lifeboats, tugs, sailing-vessels, general-service craft, harbor launches, fishing-boats, emergency wireless-plants, and engine-room auxiliary machinery. It may be mentioned that many of the large Diesel motorships turned out by the Werkspoor Company of Amsterdam use Brons type oil-engines for the electric-lighting equipment with considerable success, so doubtless the Pittsburgh engine will be used in American ships for the same purpose. It operates on the four-cycle principle.

Among the most recent of American firms to enter the marine field with an engine of this type is the Pittsburgh Filter & Engineering Co., of Farmer's Bank Bldg., Pittsburgh, Pa., and we are enabled to illustrate and describe an engine of their design and construction, which at the time of writing is running a series of shop tests.

This engine, it is pointed out, combines the economy of the Diesel principle with mechanical simplicity. It is, as is now becoming well known, entirely independent of any carbureter, hot-bulb or plate, spark-plug, high-pressure air-compressor, air storage tanks, fuel-pump or spray-valve. The compression is carried to approximately 500 lb. per sq. in. and the motor is started from cold without pre-heating and put under full lead in a few seconds. The makers state that it will burn any grade of the cheaper fuels, from kerosene to the heaviest of fuel-oils generally used in motorships; the same fuel serving for starting the motor.

In the designing of the Pittsburg engine, the aim has been to combine simplicity of construction with accessibility, and no effort has been spared to reduce the operating attention. Excellent shop facilities and the use of jigs and templates insure interchangeability of parts, which is quite a consideration if repairs have to be made at any time. But the engines are thoroughly tested and adjusted before shipment and are ready to meet the requirements when erected, so with proper care there should be no repairs needed. The engine is of the inclosed type, and the designer has adhered as far as possible to the thoroughly tested practice of modern high-speed Diesel engines. Not only is the crank-case inclosed, but the camshaft bearings, roller-levers and gears run in a bath of oil. The camshaft can be removed by taking off the front cover. Accessibility of the crankpins is provided by very large openings in the crank-case. Air to the cylinders is admitted through slotted mufflers.

Starting is accomplished by means of compressed air of about 125 lb. pressure per sq. in., each cylinder being provided with an air-starting valve. The starting is assisted by compression-relief valves. Starting and relief valve-rockers are mounted on eccentric shafts, and a single turn of the control-lever brings the engine from starting into the running position. This operation of the control-lever also shuts off the fuel to the cylinders during the starting period. Compressed-air for charging the starting-tanks is supplied by a compressor driven off the engine-shaft. The amount of fuel required is regulated by a "Johns" governor mounted on a vertical shaft. Independent from this automatic regulation of a constant engine-speed, a hand control-lever enables to slow the engine down while running.

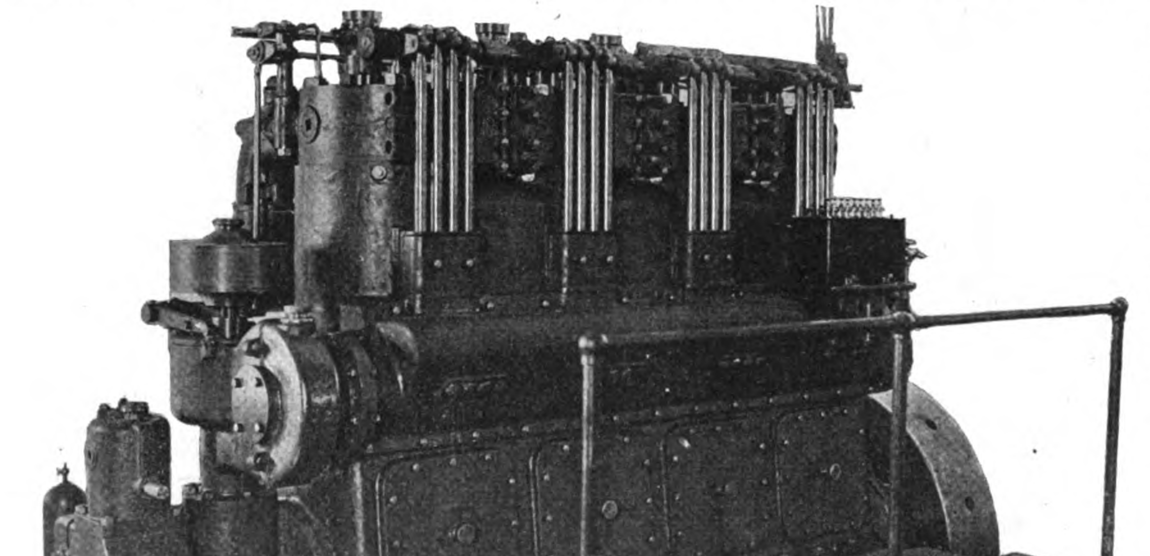
Proper attention has been devoted to the lubricating system which is complete and entirely automatic. The arrangement adopted provides for the use of two grades of lubricants for the pistons and bearings respectively. The pistons are oiled by a Richardson-Phenix force-feed lubricator driven off the camshaft. This lubricator has individual feeds and a float-valve for automatically keeping the lubricator filled when connected to an overhead reservoir, no attendance being required.

Main-bearings, crank and piston pins are at all times flooded with a copious stream of oil by a plunger pump driven off the engine-shaft. The oil is initially forced under pressure into the main-bearings, and through drilled passages in the crankshaft into the crank-pins, thence through the drilled connecting-rod to the piston-pin. The oil after leaving the bearings is collected in the crank-pit and flows to a strainer, and from here a small plunger-pump delivers it to a Richardson-Phenix filter. After leaving the filter the oil passes through a cooling-coil and is again used over again.

The base or bed-plate is of a rigid box-section cast integral with the crank-pit and seats for main-bearing shells. These shells are of cast-iron, lined with babbitt-metal. The main-bearings are provided with shims for adjustment. The shims are composed of layers of brass firmly held together by a metallic binder. An adjustment of 0.002 in. is made possible by this method.

Open-hearth steel is used for the crankshaft, and it is forged from the solid and for all smaller engines, including the four-cylinder size, is made in one piece. The six-cylinder shaft is made in two half units. It is enlarged and tapered at the end to receive the flywheel. The enlarged end also serves as coupling flange for the shaft. Cylinder frame and crankcase for engines, including the four-cylinder size, are cast in one piece; for the six-cylinder unit two three-cylinder frames are bolted together. The working cylinder proper, or liner, is of plain cylindrical form, of close grain cast-iron and held in place at the head, the end only being free to expand and contract in its length.

Mr. Louis C. Eitzen, Vice-President and General Sales-Manager of the Pittsburgh Filter & Engineering Co.



A four-cylinder Pittsburgh heavy-oil engine

No crossheads or guides being used, the piston is of the trunk type, and is of ample length to prevent excessive wear. It is of a close grain cast-iron ground to size. The inside of the top of the piston is provided with ribs for radiation of the heat as well as for strength. To seal the piston and cylinder six patented snap-rings are used. At the bottom of the piston another ring is placed preventing oil splashed from the crank-case reaching the cylinder.

The connecting-rod is of soft, open-hearth steel, machined all over. The crank-end is of the marine type, bronze boxes lined with genuine babbitt metal. For adjustment shims similar to those on the main bearings are used.

To avoid the possibility of cracks, the cylinder head is of a special grade of cast-iron symmetrical in design and thoroughly water cooled. Its inlet and exhaust valves have heads of cast-iron—also of a special mixture—welded to open-hearth steel stems. The cams, rollers and pins are of open-hearth steel, hardened and ground. The camshaft is located in front of the cylinder frame above the openings for the crankcase. The bearings for the shaft have removable, split, bronze shells. As to the valves, these are operated by rockers and rods. All rod-boxes and rollers are bronze bushed, and the entire system of cams, lower roller rockers, and bearings work in a bath of oil.

MR. LOUIS C. EITZEN

We take pleasure in announcing that Mr. Louis C. Eitzen has been appointed General Sales-Manager of the Pittsburgh Filter & Engineering Co. Mr. Eitzen since 1917 has been General-Manager of the August Mietz Corporation of New York City, well-known as builders of marine oil-engines. For the previous six years he was the Sales and Electrical Engineer for the Standard Underground Cable Co. of Pittsburgh. No doubt Mr. Eitzen's association with the Pittsburgh Filter & Engineering Co. will do much toward expanding the sales of this new marine oil-engine, because of his wide sales management and engineering experience, which includes association with the Electrical Testing Laboratories of New York City, the Bristol Pyrometer Co. He is an engineer graduate of Cooper Union and also an accounting and law graduate of the Pace Institute.

The Relation of Oil to the Great Industries of the World

America, and The Vital Question of Oil-Engined Ships

By HARRY L. DUNN

NEVER before in the history of the world has petroleum played so important a part in the making of commerce and the sustaining of nations as it does today. Never have the eyes of rich and poor been so turned toward the sources of supply of crude and refined oils as they are now, not so much with the idea of suddenly gaining riches through the holding of, or the gambling in, the stock of oil development and production companies, as from the very fact that, just as every man in every nation lives to a greater or less extent on that nation's export or import trade, so is he interested in what is rapidly becoming the greatest factor in the trade, not of any single country or of any group of nations, but of the world.

Time was when transportation depended on man's broad back and strong legs; then the dog became the burden bearer, to be succeeded by the horse, the cart, the wagon, and, finally, the steam-car and the steam-boat. All of these but steam have passed, except in the more remote parts of the world; while the far-sighted man of commerce sees in the motorship and the automobile methods of commercial transportation which rapidly are replacing steam power. In his belief—undoubtedly correct—the transportation of the world's commerce in the future will depend on the world's supply of crude petroleum. No one who has seen the modern motorship, with its greater carrying capacity, ton for ton of structural steel, with its far smaller engine-room crew, meaning the saving of hundreds of dollars daily, and that cleanliness which makes the motor freighter seem even more clean than the steam passenger carrier, can doubt that the age of oil has come to the sea, while no one who has watched the use of the automobile in the war, or has studied the use of the motor-car as supplemental to the railroad over the wonderful roads of the far West or the western half of the Mississippi Valley, can fail to feel that oil, in one or the other of its forms, used in the internal-combustion engine, is fast following the improved highways to the eventual elimination of the costly and less effective steam.

This line of thought, and of experience, must lead the man who is interested in transportation—as which of us is not?—to see that world-wide changes in the oil industry are under way, and bring him to wonder as to the probable supply of this fuel, and how long it will fulfill the drain these forms of transportation will put upon it.

Some years ago, American oil men converted some of the leading railroads of the country from coal to oil-burning. Those railroads which installed the "oil burners" never went back to coal. In Great Britain, a number of shipbuilders have seen the light, and are constructing 10,000 and 11,000 ton motorships, driven by engines using crude-oil in their cylinders, in place of steam under boilers. In the southern part of the United States, at least three shipyards of considerable size are devoting their attention to the construction of auxiliary barkentines and schooners, equipped with heavy-duty internal-combustion engines, using the lighter grades of unrefined oil, and these auxiliaries are in greater demand today for use in Latin-American commerce than steamships ever have been.

Many of the old steamship lines, such as those headed by Lord Pirrie and Sir Owen Phillips, apparently seeing the oil running down the wall, have installed oil as a fuel under the boilers of their scores of steamships. Quite possibly this is their first step toward the installation of the oil engine, as also indicated by Lord Pirrie's Diesel-driven ships, the "Glenapp," "Jutlandia," "Glenamoy," "Bostonian," etc. Railroad and steamship congestion, the difficulty and expense and large number of men necessary to the handling of fuel coal, as against the handling of fuel-oil—all these things have had an influence in bringing about the age of oil. In many of the greatest industrial centers of the world, notably in our own New England, oil is rapidly replacing coal as fuel for these very reasons.

Two of the world's greatest industrial and banking groups have been conducting for several years campaigns to enlighten the manufacturers, the ship-owners and the shippers, as well as the railroads, on the advantages of the use of oil, both as fuel and directly in internal-combustion motors. These are the Rothschilds (Royal Dutch-Shell) of Europe, and the Standard Oil Company in the New World. Men trained in the use of oil and in the exposition of its advantages, began, shortly before the world war broke out, a campaign to induce steamship companies to instal oil as fuel in their boiler-rooms, and to convince shipbuilders and shipowners that the oil-engine is more profitable, easier of operation, cheaper and more effective than the steam engine—in other words that the motorship is more adapted and adaptive to the needs of the world's commerce today than is the steamship—including the oil-fired steamer, which is but the first step towards the more economical motorship.

The easier loading of oil, the smaller crew required in the machinery rooms, and the smaller space required by an internal-combustion power plant on board the ship, all have been important factors in placing the motorship to the fore as the freight carrier of the present as well as of the future. The European war, and particularly the participation of the United States in that war, however, held up many of these changes which were to have been made, and in the rush of shipbuilding, the old and tried lines were followed, so that only now are we beginning to turn again to the motorship, not as an experiment, but as an established fact, attested by the performances of such Diesel-driven vessels as the "Glenapp" and the "Selene," and such surface-ignition engined auxiliaries as the "City of Gulfport" and "City of Portland" in trans-Atlantic service in the midst of the war.

Leading steamship men with whom the writer has talked since the beginning of this year freely admit that within the next five years virtually no ocean-going steamers will be burning coal beneath their boilers, while within the next ten years they expect to see at least half of the world's freight carried in motorships. This is a tremendous admission of radical change from men who have been devoted to steam all their lives, yet I have heard it from shipbuilders, ship-owners, and shipping men from the Great Lakes to the Gulf, and from Newport News to Seattle. Other shipowners think that no more steamships should be built, except large transocean liners.

From a naval standpoint, the oil question is of no less importance. From personal experience, I know that the American and British governments have been watching with the eyes of eagles all developments of the oil fields in the countries surrounding the Caribbean Sea. Great Britain has been vitally interested because of her colonial interests there, and the United States, because of the needs of the Panama Canal and because of the menace of violation of the Monroe Doctrine, if foreign nations get a foothold in the vast and enormously productive oil fields of Latin-America.

The British government, as is well known, has assumed direction over some of the British and British-Dutch companies operating in the oil-fields of Europe, in order that her navy may be assured of perpetual and adequate fuel supply. Great Britain, too, has been seeking possession of oil fields and oil depots and oil pipe-lines at strategic points, for use in the commercial campaigns of peace, as well as in war. Oil is a mighty factor in the fate of the Near East, and it has been no less a factor in the destinies of the republic of Mexico, while today Britishers and Americans alike are scouring the jungles far to the south of Mexico, in search of the continuation of that oil field which has made the states of Tamaulipas and Vera Cruz famous as among the greatest oil-producing sections of the world.

In Europe, for years, the burden of transportation has been placed on inland waterways, canals and natural streams, where gasoline and oil engines have played most important parts. In the United States, where the science of railroad building and management has progressed so far beyond that of Europe, the development of inland waterways, and efforts to obtain greater use of them has been confined mostly to trade organizations, such as chambers of commerce, and to private individuals, interested for profit, rather than to any large industrial, banking or capitalistic groups. We have learned, too, that the improved highway is much easier to build, less costly, and able to reach scores of settlements which inland waterways never could touch; we have learned that as an adjunct of and auxiliary to the railroad, the perfected highway is far more effective and productive of much greater results at less outlay than is the canal. Yet here enters the eternal factor of oil again, for it is the automobile and the motor-truck which have made the modern American highway useful, and in the opinion of the writer the inland waterway has forever passed its point of great usefulness or great value as a trade route in the United States. Be this as it may, the modern highway, with the automobile as its means of transportation brings out greater demand for oil and its products of gasoline and kerosene and distillate, than did ever the canal or the river or the bayou or the lake.

The demand for oil, then, comes from every form of commercial transportation: railroads, motorships, steamships, auxiliaries, automobiles, motorboats, and from the ships-of-war. The greatest question before the owners of all these means of handling the world's commerce, then, is the supply of oil. Is there enough mineral oil in the world to handle the world's commerce? Are the great oil-fields of the world being exhausted, if so, where are the new fields?

Mineralogists and statisticians have estimated officially that the world's coal supply will be exhausted in 200 years. Equally learned and experienced students of oil have said that the visible supply of oil at the present rate of production will last 900 years. With the great fields of Mexico, Trans-Caucasia, China, California, Texas and Pennsylvania, if these experts know what they are talking about—and it is to be supposed that they do—there is oil enough in the world, eliminating the development of new fields, such as the coming great Persian Gulf field, to carry the world's commerce nearly five times as long as the visible coal supply would carry it.

This is a matter worthy of deep consideration, and worthy of the attention of ship-builders, engine-makers and the owners of railroads and ship lines. It is a basis, in fact, for the motorship industry, which should put that type of vessel on every sea, and should replace many a steamship with a motorship, or at least put an internal-combustion motor in the place of many of the steam power-plants which now drive our shipping on the oceans, great seas, lakes and rivers of the world.

It is the opinion of the writer, based on a decade of life in many parts of Latin-America, and on long association with men who have grown old and expert in the oil industry, that the greatest and most productive oil fields of the world are yet to be discovered and developed below the Panama Canal. If this is true, and reports of oil prospectors in Colombia, Venezuela, and Brazil indicate that it is, the oil statisticians will have to revise their figures upward to more than 900 years, and the life of the economical motorship will be extended to one greater than that of the once-celebrated Methusaleh, unless some even more economical power is discovered.

Not the least of the demand for these motorships is beginning to come from the oil industry itself. Virtually all of South America's ports—where her few industries are located—have been operating all their industrial plants with coal. All this coal had to be drawn from the outside world, and when it was cut off by the European war, they turned to oil, largely from Mexico's abundant supply. Now, these South American industries are loth to go back to coal, and they are demanding oil by tank-ship from Mexico and from the United States. The steam plant on board an oil-tanker has always seemed to the writer a vast misuse of space which might be better employed carrying cargo, and at least one oil company, which recently completed four steel tankers, propelled by steam, converted to electricity and then applied to the propeller-shaft, I have every reason to believe sincerely regrets that it did not install oil-engines instead.

And the idea of the motorship is pervading the shipyards as well as the minds of ship-builders and ship-owners, for while three yards along the Gulf Coast are constructing motor-drive auxiliaries, another large yard, at present at work on large steel steamers for the United States Shipping Board, is now seeking contracts for the construction of steel motor-vessels, of the class and size of the "Glenapp," the large and swift British motorship recently described and pictured in "Motorship." The owners of this shipyard, which was founded in the midst of the war, when it was expected that the demand for steel steamers would persist for years, owing to the war, even now believe that the day of the motorship has arrived, and are proceeding accordingly.

Interesting News and Notes from Everywhere

CANADIAN AUXILIARY, "GASPE TRADES"

Two Fairbanks-Morse oil-engines are installed in the 209 tons-gross wooden auxiliary-schooner, "Gaspé Trades," built and owned by H. A. Ellis, shipbuilder, Barachois, P. Q., Canada.

GERMANY STARTS ORDERING MOTORSHIPS

The Sloman Company, well-known German ship-owners, have placed an order for four 8,000 tons dead-weight-capacity Diesel-driven cargo motor-ships, to be built at the Reichwerft (ex-Kaiser Wilhelm Werft) Kiel.

BRITISH MYSTERY MOTORSHIP

There has just been sold to Messrs. Arthur Tate & Co., shipowners, Newcastle-on-Tyne, England, the auxiliary barquentine, "Resolute," which during the war was used by the British Admiralty as a "Mystery" ship. She is propelled by two surface-ignition type oil-engines.

LARGE CRAIG MARINE DIESEL ENGINE

We understand that the Submarine Boat Corporation has placed an order for a six-cylinder 30 in. x 40 in. merchant marine Diesel engine of 2,000 h.p., with the James Craig Engineering Works of Jersey City. Such splendid encouragement is worthy of special notice.

MOTORSHIP OWNERS' LARGE PROFITS

A gross profit of forty million crowns and a net profit of 18,983,286 crowns was made during 1918 by the East Asiatic Company of Copenhagen, who own and operate motorships exclusively. The existing fleet of motorships consists of 12 vessels aggregating 57,444 gross tons.

MOTORSHIP CONSTRUCTION PROFITS

The net profits for 1918 of Burmeister & Wain, the Danish motorship builders, amounted to 3,449,000 kroners, as against 6,801,000 kroners in 1917, and 9,015,000 kroners in 1916. A dividend of 18 per cent. was paid, compared with 22 per cent in 1917 and 25 per cent in 1916. Only two Diesel motorships and one steamship were completed and delivered during 1918, owing to lack of materials. They also built Diesel engines for three auxiliaries and for three submarines. But, during 1918 repairs were carried out on 102 steamships and motorships as against 236 vessels in 1917.

BRITISH-INDIA STEAM NAVIGATION COMPANY ORDERS LARGE MOTORSHIP

An order has been placed for a large Diesel-engined motorship with Barclay Curle & Co. of Glasgow by the British-India Steam Navigation Co. The machinery will be built by the Diesel Engine Department of Harland & Wolff. Altogether, many large ocean-going motorships are on order at Clyde yards including eight for Glen Line, three for the Elder-Dempster Line, and twenty for the Leyland Line. Six motorships already have been launched for the Glen Line.

ANOTHER LARGE BRITISH MOTORSHIP

Glen Line's Sixth Diesel-Driven Vessel Takes the Water—Has 14 Electric Cargo Winches.

The twin-screw passenger and cargo motorship, "Glenade," which is the latest addition to the Glen Line of motorships and steamers, was launched on April 15th last, at Harland & Wolff's Govan shipyard. She is the Glen Line's sixth large Diesel-driven ship, and it is said that 14 more are on order. Her length is 420 ft. by 54 ft. breadth, and she is propelled by two Harland & Wolff-built B. and W. Diesel oil-engines. The M.S. "Glenade" will be used in the Far East service, and her measurement is 5,000 tons gross. She has every facility for the rapid loading and discharge of cargo; also comfortable accommodation for a number of passengers. There are 14 winches of special design, all electrically driven, as are also the windlass and warping winch. The vessel has two steel telescopic pole-masts with derrick tables on each, and there are in all 21 derricks, lifting from 12 up to 50 tons.

The steering-gear is of Harland & Wolff's well-known type, electrically driven. There is a complete installation of electric-light and wireless-telegraphy apparatus. All the accommodations are suitably arranged, and of a superior character. During construction the vessel has been under the survey of Captain H. M. Wily, marine-superintendent, and Mr. H. R. Hondin, superintendent-engineer of the Glen Line.

RELIABILITY

During the year 1918 the motorships of the East Asiatic Company collectively covered a distance of 842,378 nautical miles. No wonder their gross profit amounted to 40,000,000 crowns.

EVOLUTION AND PROPULSION OF THE MODERN SUPER-SUBMERSIBLE TORPEDO-BOAT

A very complete and interesting paper on the above subject was read before the Institute of Marine Engineers, London, England, at a recent meeting. Lord Weir, of Eastwood, has been elected president of the society.

LOW LUBRICATING OIL CONSUMPTION

The lubricating-oil consumption of the 1,200 b.h.p. Nordberg-Carels two-cycle type Diesel engine is 3 8/10 gallons per 24 hours, or 0.009 lb. per brake-horsepower. On this engine a make of lubricator is used that we have not previously seen on a Diesel engine.

LARGE OIL-ENGINE ORDER

The Cuymel Fruit Company of New Orleans, La., have ordered eight Mietz surface-ignition type heavy-oil engines of 100 b.h.p. each. These motors will be installed in twin-screw wooden hulls which will be used for fruit-carrying from Honduras to New Orleans. The vessels were designed by Wm. Gardner & Co. of New York.

BRITISH ADMIRALTY DIESEL-TUG OF 1,200 H. P.

The British Admiralty tug "St. Olaves" of 468 tons, recently built at Govan is fitted with a Harland & Wolff built Diesel engine of 1,200 H. P. The "St. Mellan's" and the "St. Aubin" are sister vessels now being built, and as they are steam powered, some most valuable comparison data should soon be available. The "St. Olaves" is the largest motor tug in the World.

"VICTOIRE" A 130-FT. PATROL VESSEL FOR FRANCE

The 130-ft. motor wooden patrol-vessel, "Victoire," built by the Gas Engine & Power Co. and Chas. L. Seabury, Consolidated, Morris Heights, New York City, has left this country for France—her owners being the French Government. Three 250 b.h.p. Speedway motors are installed.

CONCRETE MOTOR-VESSEL AT SYDNEY, N. S.

A concrete motor-vessel, which is now nearing completion will be launched within a few weeks by Mr. W. N. McDonald of Sydney, Nova Scotia. This craft is of the following dimensions: Length 127 feet, breadth 27 feet, depth 12 feet. She will be equipped with one 240 B.H.P. Bolinder surface-ignition type heavy oil engine.

DANISH CONCRETE MOTORSHIP

The following are the dimensions of the Diesel-driven concrete motorship previously referred to as being under construction in Denmark under supervision of the Norwegian Veritas:

Displacement	2,300 tons
Dead-weight Capacity	1,250 tons
Length b.p.	196 ft.
Breadth	33 ft.
Depth	16 ft.
Weight of hull and machinery	1,150 tons
Type of vessel	Single-Screw
Type of engine	Four-Cycle Diesel
Make of engine	Frichs
Power of engine	400 b.h.p.
Speed of engine	190 r.p.m.
Number of cylinders	Six
Bore and stroke	11.2 in. by 19.6 in.
Propeller	4 blades, 7 ft. dia.

The engine was built by the Frichs Engineering Works, Ltd., Aarhus, Denmark.

ORDER FOR ELECTRICAL AUXILIARY MACHINERY

The Pacific Machine Shop & Manufacturing Company of Seattle have secured the order for the electrical auxiliaries for the five full-powered motorships being built by the Patterson-MacDonald Shipbuilding Company, Seattle, Wash., for the Australian Government. This order includes for each vessel the anchor windlasses, cargo winches, capstans, steering gears, pilot house telemotors, and the generating units which are driven by two Fairbanks Morse motors, type "Y" of 75 and 37½ b.h.p. This company is also making all these installations. The first vessel is expected to be fully equipped and ready for her trials in about a week.

NEW CHINESE-BUILT MOTORSHIP FOR MANILA

There has recently been built by the Kianon Dock Co., of Shanghai, China, the auxiliary motorship, "Vigan," to the order of the Cia Naviera, of Manila, P. I., and in which vessel two six-cylinder oil-engines are installed as auxiliary power. She flies the American flag and is of 819 tons gross.

RUSSIAN MOTORSHIPS SAFE

We understand that the Caucasus & Mercury Shipping Company succeeded in transferring the greater part of their extensive motorship fleet from the river Volga, Russia, to the Caspian sea, where these large Diesel-driven vessels now are under the protection of the British Government. M. Jules J. Hessen, a director of this company, was largely responsible for the success of the task. This motorship fleet was illustrated and described in "Motorship" of March, 1917, on pages 10 to 17. Up to that date it consisted of 12 motorships of 130 to 1,200 b.h.p. each. None of these motorships are registered in the British Lloyds.

SMALL MOTORSHIPS FOR TEXAS COMPANY

Another Craig-Diesel engined motorship—the "Texaco 145," a tanker of 600 tons d.w.c.—was launched at the shipyard of the Texas Steamship Co. last April for the Texas Company of New York, and it is reported that two sister vessels are about to be launched. Her length is 153 ft. and a six-cylinder four-cycle type oil-engine, built by the James Craig Engine Works, Garfield Avenue, Jersey City, N. J., is installed. We understand that the expected success of the small motorships, which the Texas Co. are having built, will, if realized, cause them to construct much larger motor tankers.

BIG BRITISH ELECTRIC COMBINATION

A new company has been formed in England, known as the "English Electric Company, Ltd.," with head-offices at Abchurch Yard, Cannon Street, London, E. C. 4. This is a combination of Williams & Robinson, Ltd., the Diesel-engine builders of Rugby; the Coventry Ordnance Works; Dick Kerr & Co., Ltd.; the Phoenix Dynamo Mfg. Co., Ltd.; and the United Electric Car Co., Ltd. The capital is $25,000,000.00. The joint managing directors are Lieut. Col. Sir John H. Mansell, K.C.B.; Mr. P. J. Pyby, O.B.E., and Mr. W. Rutherford. We also understand that the Fairfield Shipbuilding & Engineering Co., Ltd.—also Diesel-engine builders—are connected financially, holding a considerable amount of stock.

UNIQUE DEMONSTRATION OF MOTORSHIP'S ADVANTAGES

The fallacy of the argument that surface-ignition or hot-bulb engined vessels are at a disadvantage in getting under way as compared to other vessels was recently demonstrated in a spectacular way at New York. The motorship "Lake Mohonk" and the steamship "Saranac" have been tied up idle in the North River for some time. A severe blow came up on the night of March 28th, and both vessels began to drag their moorings. The order was given to get under way and, although the "Lake Mohonk's" engines had not been operated for two weeks, they were turning over at full-speed nine minutes later. She headed out into the stream and escaped without a scratch. The steamship "Saranac" piled up on a nearby dock and was badly damaged owing to the fact that five hours elapsed after the order was given before sufficient steam could be gotten up to turn her engines over. The incident is vouched for by Chief-Engineer H. C. Southwick, Jr., of the "Lake Mohonk." He adds that the "Lake Mohonk," which was built by the Manitowoc Shipbuilding Co., and fitted with two 320 H.P. Bolinders, has given a splendid account of herself despite the fact that she is under powered.

She was not a modern motorship, but an old coal-burning tramp coaling alongside the wharf. The skipper, who was an ill-tempered bully and very unpopular, was watching operations. Just above his head was a sling with ten sacks of coal. Behind the "old man" was a sailor kneeling, in an attitude of supplication, with hands uplifted. A pal asked him what he was doing. And the answer came pat: "Praying the blooming coal will fall on the slob."

Coal Tar-Oil As Diesel-Engine Fuel

The Experiences of Some Users

AT a recent meeting of the Diesel Engine Users' Association in London a short note was read by Mr. John Milton on the use of tar oil with Diesel engines without the employment of pilot ignition. Although this had special reference to stationary motors, it is of some interest from the marine aspect as the ships of users of marine Diesel engines may at some time need fuel when in Great Britain, or when calling at other places remote from the oilfields where the price remains high.

The alterations on the engines in question comprised the fitting of a special form of flame plate with a cone orifice. The number of pulverizer rings was varied and the period of fuel admission and distribution were varied, but apart from these modifications no changes were made for the satisfactory operation on both classes of fuel.

The particulars of the two Willans and Robinson Diesel engines installed are as follow:

Three-crank, 230 b.h.p., 200 r.p.m., cylinder diameter 380 mm., stroke 560 mm., 150 k.w.

Four-crank, 307 b.h.p., 200 r.p.m., cylinder diameter 380 mm., stroke 560 mm., 200 k.w.

The range of load available for tar oil is about half to full load without pilot ignition.

The four-crank engine was first readjusted, and the particulars are as follow:

Before alteration.	Cyl. 1.	Cyl. 2.	Cyl. 3.	Cyl. 4.
Admission angles....	5.05°	3.70°	4.30°	6.15°
Before top dead centre measured cold.				
Flame plate openings	mm. 3.8	mm. 3.8	mm. 3.6	mm. 3.6
Pulverizer rings.....	2	2	2	3

(Fuel distributer adjusted to give even loading.)

After alteration.	Cyl. 1.	Cyl. 2.	Cyl. 3.	Cyl. 4.
Admission angles....	7.40°	7.00°	7.03°	7.85°
Before top dead centre measured cold.				
Flame plate openings	mm. 3.71	mm. 3.73	mm. 3.68	mm. 3.68
Pulverizer rings.....	3	3	4	5

(Fuel distributer adjusted to give even loading.)

Considerable difficulty was experienced in obtaining even loading with both classes of oil. The characteristic being with crude oil 1 and 2 lines heavy, 3 and 4 lines light; and with tar oil, 1 and 2 lines light, 3 and 4 lines heavy. The difference between light and heavy was about 20 per cent. This was finally overcome by altering the number of pulverizing rings.

In the case of the three-crank engine, the cone flame plate's admission angle of 7 degrees, and one extra pulverizing ring on each line, effected all that was required, no uneven loading between the lines being experienced.

The blast pressure used with tar oil is the same or slightly higher than that required for crude oil.

Temperature of Cooling Water

Regarding the cooling water, an outlet temperature of 125 degrees F. to 135 degrees F. was maintained at first, but there appears to be a distinct advantage with a lower temperature, say 105 degrees F. Before changing over on to tar oil the temperature is raised to 120 degrees F. to facilitate going over, after which it is dropped to 105 degrees F. With the higher temperature there was a tendency for the crossheads to knock at times, particularly before the admission points were advanced.

The standard pulverizers require cleaning approximately every 50 hours. By changing over on to crude oil 15 minutes before shutting down, instead of just long enough to get the crude oil through, it is found that the cleaning effect on the pulverizers is marked. The general effect of using tar-oil on the engines seems to be negligible, but the fuel-pump valve requires more frequent attention, and it is more difficult to keep the glands tight.

Regarding the storage of tar oil, our experience seems to point to the fact that better running is obtained if the oil is continuously stirred, thus keeping the constituents of different specific gravity well mixed. In addition to the stirrer in the main storage tank, there is a small stirrer in the service tank which feeds the engine filter by gravity. This second stirrer has two small vanes, about 4 ins. long, and is driven by a small vertical shaft punkah fan motor in series with a 210-volt 60-watt lamp.

In connection with the deposit of naphthalene crystals at low temperatures, an increase in the speed of stirring partly overcame this, but successfully to deal with this difficulty it was found necessary to apply heat to the oil pipe feeding the filter. The heat was applied electrically by winding about 30 yards of No. 22 S.W.G. resistance wire on a piece of asbestos sheet moulded to the pipe close to the filter. This is run at a dull red heat, and the energy absorbed is about 1 kilowatt.

Experiments are also going to be made with the sleeve pattern pulverizer, which appears to overcome the choked pulverizer difficulty.

In the discussion following the paper Mr. H. Squire stated that one of the chief troubles experienced was in getting the tar oil out of the railway tank wagons in the cold weather if the wagons are held up on the journey for 10 days, since some 20 per cent of the contents set solid during this time. The storage tanks at the power station were fitted with 1¼ in. steam heating pipes, maintaining a temperature of 65 degrees F. at the bottom and 75 degrees F. at the top. Stirring was not found to be necessary.

Cost of Fitting Pilot Jet Ignition

Mr. G. Porter remarked that he had used creosote oil for 18 months, fitting a pilot jet ignition gear (C. Aust system) and had had satisfactory results. The cost worked out $4.00 per b.h.p. on a 200 four-cylinder engine and $3.50 on a 375 b.h.p. three-cylinder engine. The cost was extinguished in five months. He suggested that exhaust gases should be used for heating the tar oil.

Mr. P. H. Smith made the following communication:

Of the three systems with which I have become acquainted for burning tar oil without pilot ignition there is none possessing all the advantages of the other two without some disadvantage rendering it unsuitable in particular instances. Perhaps a comparision of the advantages and disadvantages of each will be of interest.

System I.—No Radical Alteration to Engine.

Range of Load.—My definition of range of load is "The range of load which can be got out of the engine without misfiring, bumping, or smoking." This is usually one-eighth load to overload with crude oil.

With little or no alteration to the standard engine the range in load of tar oil is as follows:—

Willans ("B" type)—overload to about five-eighths.

Carels (all types)—overload to five-eighths.

Mirrlees (open type)—overload to three-quarters.

Sulzer (small engines)—overload to three quarters.

Blast Pressure.—Normal or slightly less.

Fuel Consumption.—10 to 12 per cent more than with crude oil.

Quantity of Crude Oil Required.—With continuous running, e.g., 100 hours weekly without a break, at large loads, about 15 per cent crude oil is employed.

Advantage.—No initial cost.

Disadvantages.—Engine liable to fitful "bumping" even when working within its useful loading range; range in load usually too small; dangerous on small loads; pulverizers choke after 50 to 100 hours.

System II.—Sleeve Pulverizers and Sharp-edged Flame Plates.

Nearly 20,000 b.h.p. are running on this system.

Range of Load.—Willans ("B") type)—overload to four-tenths and sometimes to three-tenths.

Carels engines (all sizes)—overload to four-tenths.

Mirrlees (open type)—overload to one-half.

Sulzer engines—overload to one-half.

Blast Pressure.—Normal, or slightly higher than with crude.

Fuel Consumption.—5 to 6 per cent higher than on crude oil.

Quantity of Crude Oil Required.—This depends upon conditions as stated above. When the engine runs long hours at medium to heavy loads the tar oil may be as high as 95 per cent of the total oil burned. It averages 85 per cent throughout the country, taking poor conditions into account as well as small engines.

Disadvantages.—Not yet suitable for the small loads.

Advantages.—Quickly fitted; best economy at large loads; pulverizers never choke nor wear out; interchangeability assured.

System III.—Whirling Flame Plates.

Pulverization is effected by giving fuel a rapid rotary motion just before it enters the cylinder. It then disintegrates by centrifugal force into a very fine mist.

Range in Load.—I have had experience of this system on a number of small Sulzer and Mirrlees engines, but have never tried it on larger units. On these engines the range in load within my definition given above is three-quarters, and the engine may be set to one-eighth to seven-eighths, or one-quarter to full. Overload is very difficult to obtain with the latter setting, and reliable dead light running without misfiring does not yet appear to be practicable.

Blast Pressure.—At the top limit of load the blast pressure is high, namely, 1,100 lb. per sq. in., to get a clear exhaust.

Fuel Consumption.—Very good indeed on small loads, but 12 to 18 per cent high on full load as compared with the standard engine on crude oil.

Quantity of Crude Oil Required.—This again depends on conditions, and may be as low as in System No. 2.

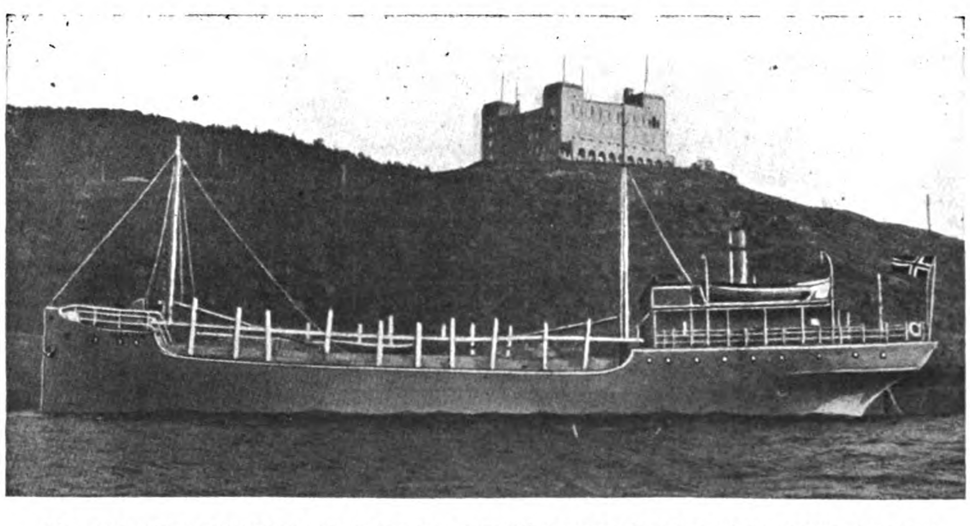
Disadvantages.—In some forms interchangeability of parts is not easily assured, also the flame plate cuts, thus raising the useful loading range, say from one-eighth to seven-eighths to one-quarter to full. (Sometimes there is a slight whitish vapour at all loads, which gums up the exhaust valves.

Advantage.—Excellent economy on light loads.

Application of Systems According to Circumstances.

Of the above systems I know of no case where No. 1 is to be recommended. The other two have their particular spheres of utility. Thus, for large engines working long hours at medium and large loads, sleeve pulverizers and sharp-edged flame plates are most suitable. But for small engines, working at medium and small loads, the whirling plate is the better. In one electric station with which I am acquainted, and where there are two four-cylinder units developing 150 kw. each, the one is fitted with sleeve pulverizers and sharp-edged flame plates; the other with sleeve pulverizers and whirling flame plates. This station has remarkably good results, using only 5 per cent of crude oil, and that only for starting up and shutting down.

In some cases pilot ignition must be adopted. For example, where the load is constantly fluctuating between wide limits or where the engine is started and stopped eight or ten times a day, it is advisable to employ pilot ignition.



The motorship "Aarsten," 650 tons d.w.c., propelled by a 240 b.h.p. G. G. direct reversible heavy-oil engine

Our Readers' Opinions

(The publication of letters does not necessarily imply Editorial endorsement of opinions expressed.)

USING OIL UNDER BOILERS IS A CRIME, SAYS OIL COMPANY

To the Editor of "Motorship,"

Sir—The burning of petroleum oil under boilers is an economic crime, and it will not be many years before it is recognized as such. The internal-combustion engine is the only way for use of any petroleum products for power produced.

Yours very truly,
WAVERLEY OIL WORKS CO.,
Per G. J.

Waverly Oil Works Co.,
Pittsburgh, Pa.

CAPT. DOLLAR AND THE SHIPPING LAWS

To the Editor of "Motorship,"

Sir:—

I am enclosing herewith a clipping from the New York "Evening Post," from an article by Capt. Robert Dollar, relating to the *cost* of ship operation, which I wish you would read carefully and, if in your judgment, the article is correct and there really is such a discrepancy in our measurement of ships which gives foreign bottoms preferential port charges ranging from $500 to $32,000, that you do all in your power to bring this abominable error to the notice of our Government and to your readers, that we may have a prompt revision of the laws of measurement that will put this country on something of an equal footing with our competitors in the Merchant Marine.

I am quite sure that the above condition does exist, and we ought to be forced to see how impossible it is to attempt to compete with such conditions against us, and that fact alone is enough to discourage any ship or engine building company from entering the field, though they be Diesel-engine builders.

I know that you are as interested in this matter as any man is in this country, and I believe that you will lend every aid in your power to correct this unwarranted condition.

Yours very truly,
F. S. HAMMOND, Lieutenant.

604 West 125th St.,
New York City.
April 8, 1919.

[Congress will shortly investigate the entire shipping question. But the advantages to be gained by changing our existing shipping-laws are very small compared to the gains that would result from changing our present steamships to Diesel oil-engine power. If Capt. Dollar built some motorships he would find that each vessel would mean a quarter-of-a-million dollars per-annum additional income. Capt. Dollar refers to the difference in wages, and board of men on the American steamer "Algoa," versus the British steamer "Robert Dollar," to be $23,544.00. Looking at Capt. Dollar's figures we see that the "Algoa" carries nine firemen and six coal-passers. In other words, *fifteen* men whose wages and food would be entirely dispensed in a motorship. No doubt some of our laws need modification, but first let us have a type of vessel that we can operate at a profit, regardless of domestic rules and regulations.—*Editor.*]

EVEN OUR BACK NUMBERS ARE READ TODAY

To the Editor of "Motorship."

Sir—As an indication of how your publication is read and appreciated in foreign countries, as well as in the United States, it may interest you to hear that we have just received a cablegram from one of our friends in Sweden, requesting us to send them your journal, "Motorship," for the last five years.

Yours very truly,
S K F INDUSTRIES, INC.,
Per R. Wikander.

165 Broadway, New York, N. Y.

PERFORMANCE OF THE MOTORSHIP "ADRIEN BADIN"

To the Editor of "Motorship,"

Sir:—

Having read of a number of motorships' performances in your journal, and being a firm believer that they are the ships of the future, I thought it wouldn't come amiss if I sent a record of this vessel's performances.

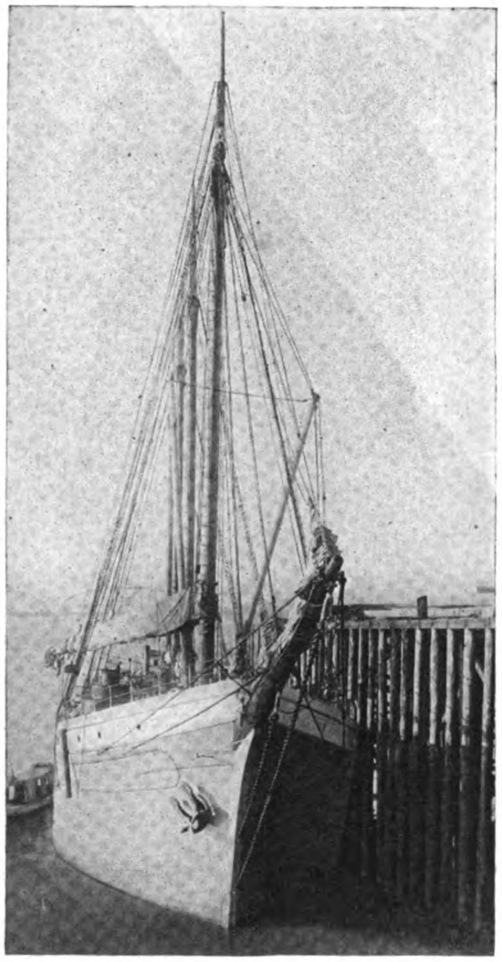
We left Portland Oct. 12, 1918, and arrived at San Francisco Oct. 16th. Left San Francisco Oct. 20th for Shanghai, China, and arrived there Nov. 26th. *Distance sailed, 6,900 nautical miles.* We weathered two typhoons without any trouble.

Left Shanghai Jan. 5th and arrived at Surabaya Jan. 20th. *Distance, 2,800 nautical miles.* Sailed from Surabaya Feb. 12th and arrived at Colombo March 1st. *Distance, 2,300 nautical miles.* We had to go against the current of the N. W. monsoons for nearly half of the trip.

Left Colombo March 11th and arrived at Suez April 3rd. *Distance, 3,507 nautical miles.*

We have had no trouble with the engines, except when we got oil at Surabaya that was of very poor quality, it containing too much sulphur, and ruined our valves. (Another reason why vessels should have good fuel-capacity, and they should carry it in double bottoms. Also the saving in the difference of price would be considerable.)

Another thing is that these motorships are woefully under powered. Our vessel was built at the Peninsula Shipyards at Portland, Ore. She is certainly a credit to the builders, as I never was in a finer seaboat, and her accommodations are splendid. We have two Winton-Diesel engines of 300 h.p. each, and they work like a watch, and do all that can be expected in a hull of this size.



The "Adrien Badin"

But, it seems ridiculous that these ships should be compelled to go hundreds of miles out of their way for winds, when they are so economical in all respects. To give them a square deal they should have as much power as a steamer. You can get a certain amount of speed out of these vessels with a strong, fair wind, but no more. Whether the wheels act as a drag after a certain speed is reached or not, I cannot say; but I think there is something in my view, for we have had winds that would send any vessel along at 19 knots, and all we could get out of her was 10 knots. Another bad feature is steam-driven cog-winches aboard these vessels. We only have a donkey-boiler and have to "crowd-it" all the time when working cargo with the four winches, whereas if we had friction winches we only would use 50 per cent of the steam in motorships that have no main boiler to draw from.

Another mistake is to have a steam-engineer for chief. I have had the experience, and all he was good for was to hand tools to the men that did know something and run up expense bills.

I have been practically around the world in this motor-vessel, and we are ready to duplicate the performance at the present moment. When docking we have not used any tugs, nor assistance of any kind, and in reversing in close quarters the engine works quicker than the most steam vessels. Also, in entering and leaving San Francisco we used the North and South Channels, so you can see the dependence we put in her Diesel engines. Also if these type of vessels get the same chance as a steam vessel they will show to advantage every time.

If the U. S. A. desires to compete in foreign trade they can't expect to do so with vessels of one and two thousand tons when the other nations have eight and ten thousand tonners. We have met quite a few of the Dutch and Danish motorships in the Orient and at sea. *They are the type of ship we shall have to operate if the American merchant marine is to be expected to hold its own.* Also in the various parts that I have touched there seems to be all kinds of business for American vessels. The U. S. Consuls admit it, but they can't do the job themselves.

I have had 26 years' sea experience in all kinds of vessels, and am thoroughly convinced that the proper size and powered motor vessel cannot be beaten. But the sails should not be considered at all, except on the Australian run on the Pacific, and then not too much. Put the motorship on the same basis as the steamship. Also, the shipowner should be content with the advantages of the Diesel motors without trusting to the winds.

We are delivering this vessel to French owners at Marseilles, where we expect to arrive April 16th. Hoping this will be of interest to you, I remain,

Yours very truly,
ROBERT FERGUSON,
Captain M.S. "Adrien Badin."

M. M. & Pilots,
65 Stewart St.,
San Francisco, Cal.
April 7, 1919.

[Captain Ferguson speaks about the underpowering of these auxiliary motorvessels. "Motorship" has repeatedly drawn attention to this mistake on the part of shipowners, who have endeavored to reduce first cost, but at the expense of efficiency.—*Editor.*]

ELECTRICAL AUXILIARIES OF THE M.S. "BULLAREN"

To the Editor of "Motorship,"

Sir:—

We have read your interesting article, "New 13-Knot Swedish Cargo and Passenger Motorship," in the January issue of "Motorship." We beg to point out, however, that a slight error has been made with regard to the electric motors. These are all of our make; even though some of them have been delivered by Electricitsts Aktieselskabet Asea, Copenhagen, which is our subsidiary Company in Denmark, and selling motors of our make only.

Yours very truly,
ALLMANNA SVENSKA,
Elektriska Aktiebolaget.

Västeras, Sweden.

[The name of the E/A Asea was on the name plate of the motors, which accounts for the mistake.—*Editor.*]

PERFORMANCE OF THE M. S. "SHEREWOG"

To the Editor of "Motorship,"

Sir—I was interested in reading the account of the voyages of the wooden auxiliary-schooner "Sherewog." As I figure it out, this boat only ran two and a half months, its actual running time in about a nine months' operating period. Was this caused by some trouble with the engine, or is this the usual proportion?

I wish you would publish some complete figures of operating costs, showing all items entering into the cost of operating motorships, including insurance, crew, expense, etc. I think such information would be of great value.

Yours very truly,
P. R. MORE.

M. M. Davis & Son,
366 5th Ave., New York.

[Doubtless the owners, or builders of the "Sherewog" will be glad to answer Mr. More's questions.

Regarding complete operating costs, the U. S. Shipping Board is preparing some very complete motorship operating data which we hope to publish as soon as it is ready.—Editor.]

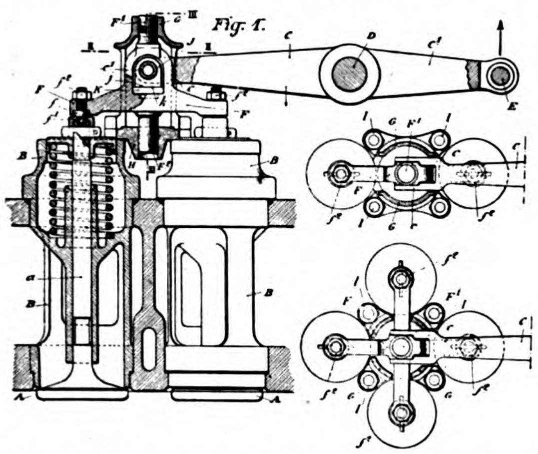
"Motorship" Illustrated Patent Record*

Selected Abstracts of Recent Published Patents of Internal Combustion Engines

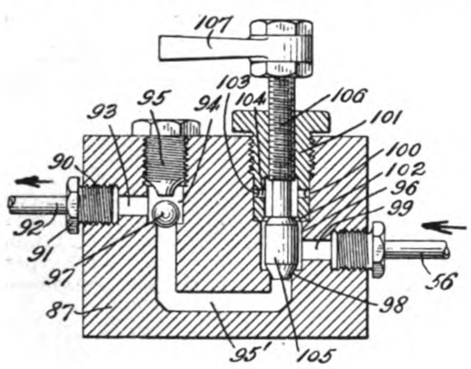
Copies of original specifications may be obtained for five cents each, by addressing the "Commissioner of Patents, Washington, D. C."

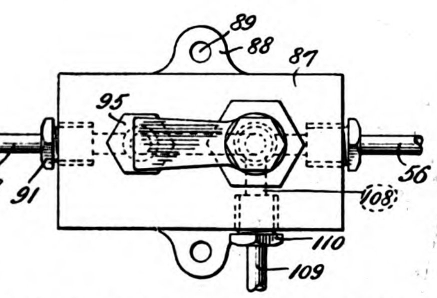
*Compiled and described by H. Schreck, Memb. Amer. Soc. Mech. Eng'rs

1,290,790. Jan. 7, 1919. Valve Operation. E. Schneider, of Paris. Assignor to Schneider & Cie., of Paris, France.
This invention relates to the operation of a plurality of valves by a common member, such as, a lever or a rocking arm.



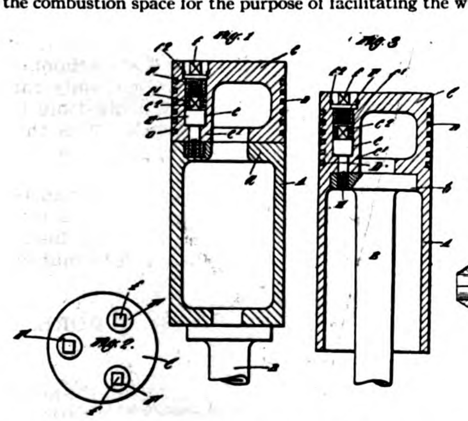
1,293,601. Feb. 4, 1919. Fuel-oil Supply Test Casing. Alexander Winton, of Lakewood, Ohio.
This invention refers to an internal combustion engine in its usual arrangement, such as, fuel pump with one plunger for each cylinder, supply line to each cylinder, injection valves etc. The invention interposes, as common practice is, in the fuel oil line a test valve in order to free air bubbles when the line is being filled up or in order to ascertain whether each pump is supplying fuel





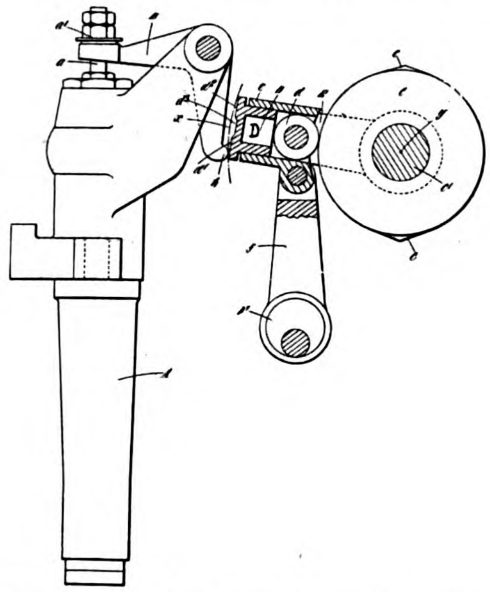
The illustration shows the special arrangement of the invention. The fuel oil supplied from the pump enters through 56 and in operating condition leaves at 97 passing to the respective cylinder. When the oil supply is to be tested the valve 105 will be closed as the illustration shows and the oil will flow through the holes 103 to the pipe 109 and into the open.
A device of this or some similar arrangement has to be and is on every Diesel-engine ever since Dr. Diesel invented his engine.

123,402. Piston. Swan, Hunter & Wigham Richardson Ltd., & M. O. Wurl, both of Newcastle-on-Tyne (British Patent).
This invention relates to pistons on which the holding down bolts of the piston top or of the entire piston are accessible from the combustion space for the purpose of facilitating the withdrawal



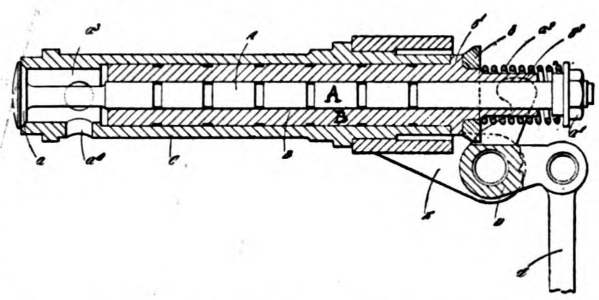
of the piston head or of the entire piston body for examination or other purposes. Said bolts are protected from overheating by special plugs and a spring is inserted between the plugs and the bolts in order to prevent slackening of either of them. Figure 3 represents this arrangement on a watercooled piston head.

1,294,077. Feb. 11, 1919. Variable Operation of Fuel Valves. H. E. Fenchelle, of Genoa, Italy, Assignor to W. L. Kann, of Pittsburgh, Pa.
This patent refers to the operations of fuel valves.
A lever f controlled in its position by an eccentric F, is attached to an arm E the one end of which is supported by the camshaft y and the other end of which carries a sliding member D. This member is actuated by the cam and the roller d and will in turn operate the valve lever when in position as shown. If however



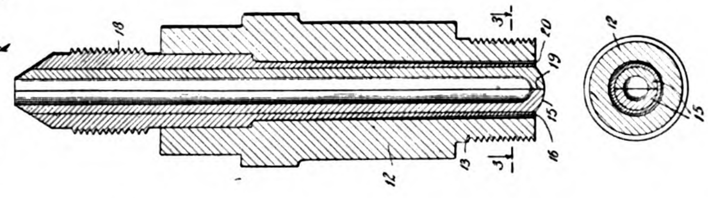
the lever f is pulled halfways downward by turning of the eccentric the nose of the valve crank will be opposite a gap or depression of the member D and the crank thereby made inoperative. If the lever is then still further pulled down the upper part of member D will come in action which may be used for the reverse movement of the engine.

1,294,078. Feb. 11, 1919. Starting Valve. H. E. Fenchelle, of Genoa, Italy, Assignor to William L. Kann, of Pittsburgh, Pennsylvania.
This invention refers to a special design of a starting valve. The starting air enters at a4. A sliding piston B, which has a larger area than the valve will be raised by the air pressure until its upper end reaches the under surface of the nut a1. In this position the valve is held closed by the air pressure and the opening of the valve will be actuated by a forked lever b2 the operation of which is controlled from the distributing shaft.



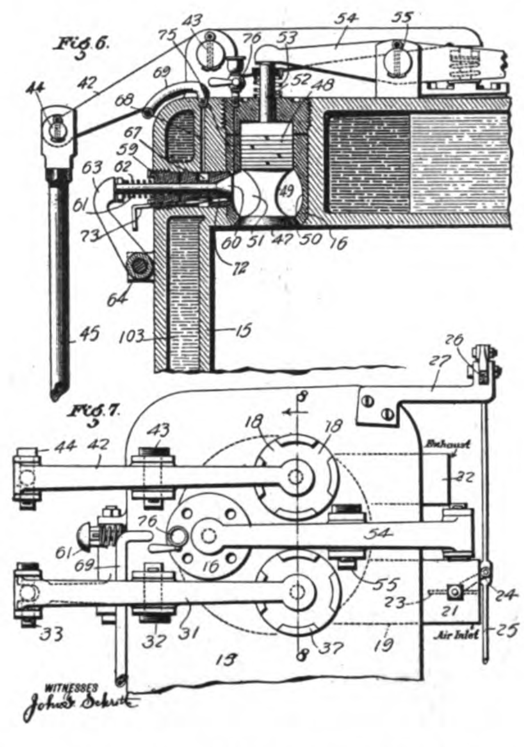
Two particular features are embodied in this arrangement firstly, the valve A will not open when there is a pressure in the cylinder higher than that of the starting air, in that case, cylinder B will simply be moved up and down and, second, for this very reason, when the engine begins to run on oil, lever d does not need to be disengaged and after the starting air cut-off valve is closed even piston B will automatically come to rest.
It may be of interest to learn that the Mc Intosh Seymour Corp. have been using for some time on their 300 H.P. Diesel-engine a starting valve working on the same principle.

1,295,612. Feb. 25, 1919. Spray Valve. P. L. Scott, of Syracuse, N. Y.
This invention relates to injection valves particularly adapted for solid injection type engines. To secure a sufficient degree of pulverization of the fuel the invention has adapted a pair of metallic quills 15 which are normally held together throughout their length by a surrounding sleeve 16 which is made of high grade spring steel and shrunk on the quills. When, however, the pressure of fuel supplied by the pump rises in the valve to a point where the resistance to the deformation of the spring-steel jacket is overcome the tips of the two quills will separate slightly, a narrow aperture will be formed and the oil will be sprayed under high pressure and at a high velocity in a flat fan-shaped form into the combustion chamber of the cylinder.



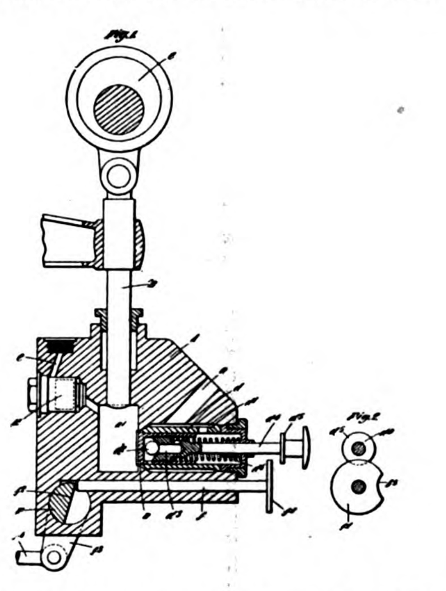
The inventor is adding rather interesting figures by stating that with a certain fuel oil issuing from such a valve under a pressure of from 2,000 to 3,000 pounds per square inch will burn either very sluggishly or not at all when ignited by a match in the open air. At 4,000 pounds per square inch, this oil will burn readily and at 6,000 pounds per square inch it will burn explosively.

1,280,807. Oct. 8, 1918. Internal Combustion Engine. S. Moore, of Monroe, Ga.
This patent refers to an engine on which a gaseous fuel is supplied to the working cylinder not together with the air necessary for combustion, but separately and the fuel at a time when the ignition is to take place, thus obviating preignition and other difficulties of engines with carburated fuel supply.
The various valves are shown as exhaust 18, air intake 17, oil intake 16-47, and oil feed valve 60. A pump maintains the oil supply at a constant pressure, and the oil enters through the channel 72 and is admitted to the oil chamber 51 by the mechanically



operated valve 60. When the piston approaches the end of its compression stroke, the fuel valve 47 is opened, air will be forced into the chamber 51, and the high temperature of this air will ignite the charge without the necessity of sparking or ignition means.
Reader may perhaps notice that a fuel valve of a relatively large diameter has to be opened against the high compression, and furthermore that there are no means provided for the proper mixing of fuel and combustion air.

1,287,660. Dec. 17, 1918. Fuel Pump. H. E. Fenchelle, of Genoa, Italy, Assignor to William L. Kann, of Pittsburgh, Pa.
This patent refers to a fuel-pump of a Diesel-engine, the delivery of which can be adjusted according to the load imposed on the engine. The stroke of the pump-plunger B is constant. The fuel is drawn in through the suction valve D and the ball valve D^2. On beginning the delivery stroke of the pump the pressure on the fuel first drives back the piston-valve D, the time



interval required for same will depend on the extent of the previous inward motion of the valve, which is limited and controlled by the stop plate F^1, which in turn is under the control of the regulating shaft F.
The suction-valve itself may be used as a hand-operated pump for starting purposes.

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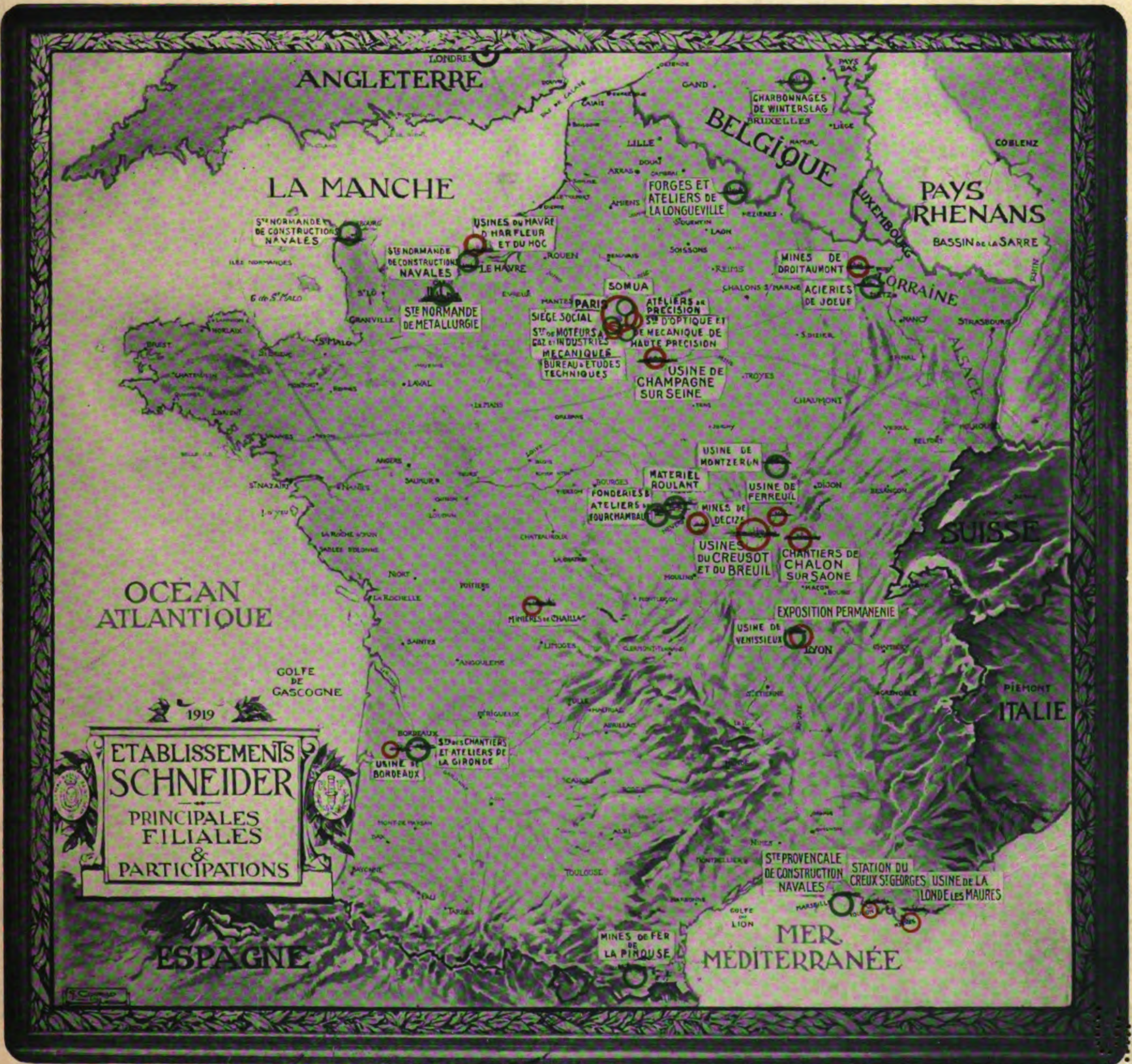


Establishments and Associated Works of Messrs. Schneider et Cie in France.
Denoted by Brown and Green Circles Respectively.

BIOGRAPHICAL NOTICE

MONSIEUR EUGENE SCHNEIDER, Iron-master, who was a Member of the Chamber of Deputies from 1898 to 1910, was born at Le Creusot (France) in 1868.

He is the grandson of Joseph Eugène SCHNEIDER (1805-1875) Iron-master at Bazeilles, who, at the beginning of the last century, purchased the old Royal Iron Foundries at Le Creusot, built in 1782, under the direct patronage of King Louis XVI; who founded the present Firm and was a Minister and President of the Legislative Corps during the reign of Napoleon III, and a Member of the Emperor's Privy Council.

He is the son of Henri SCHNEIDER (1840-1898), who considerably extended the Works and was a Member of the Chamber of Deputies from 1869 to 1898.

Monsieur Eugène SCHNEIDER married Mademoiselle de RAFELIS SAINT-SAUVEUR (a granddaughter of the Duke of FITZ-JAMES and, consequently, a descendant of King JACQUES II).

By this marriage, the following children were born:

Messrs.

Henri-Paul, Iron-master, Lieutenant, Pilot in the Flying Corps, killed during an air-fight on 23rd of February 1918. He had been awarded the Cross of the Legion of Honour and the Cross of War (twice mentioned in dispatches).

Jean, Iron-master, Lieutenant, Pilot in the Flying Corps, has obtained the Cross of the Legion of Honour and the Cross of War (3 times mentioned in dispatches).

Charles, Iron-master, Lieutenant of Artillery, decorated with the Cross of War.

Mlle. May.

Monsieur Eugène SCHNEIDER commenced his industrial career at an early age. As far back as 1887, after he had finished his studies and military service, he co-operated with his father who soon made him his partner. In 1898, when Monsieur Henri SCHNEIDER died, he alone remained at the head of the concern and also suceeded his father as a Member of the French Parliament, which he left in 1910 so as to be able to devote all his energies to the development of his Works and to the creation of new enterprises.

Monsieur Eugène SCHNEIDER is the Chairman of the great English Association—the Iron & Steel Institute; he is also Honorary President of the Comité des Forges de France, besides being President and a Director of many industrial Companies.

Monsieur Eugène SCHNEIDER has been awarded the 1919 Gold Medal of the "Mining and Metallurgical Society of America," for "Distinguished Service in the Metallurgy of Iron and Steel."

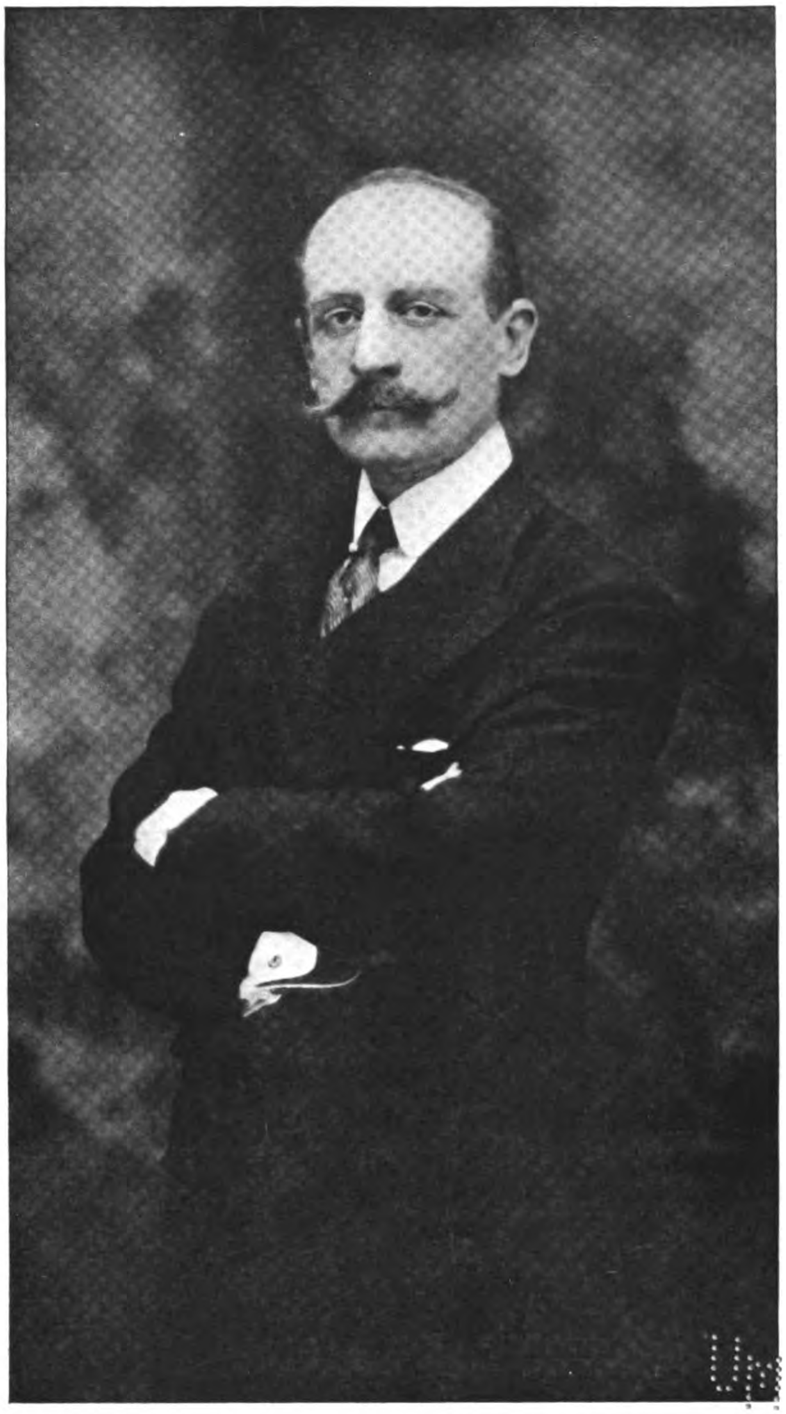
*
* *

From a social point of view, Monsieur Eugène SCHNEIDER has constantly striven to develop, with reasonable but efficient steadiness of purpose, high moral and proper hygienic principles; in short, to improve by every possible means the material conditions of life among his workmen.

On the other hand, Monsieur SCHNEIDER has improved the establishments founded by his father and has studied and solved new problems so as to promote the moral and material welfare of his entire working staff. Special arrangements have thus been made in connection with the safety of workmen, the creation of professional high schools, the development of mutual benefit societies, medical inspection of schools, the establishment of schools for teaching household economy, education of fatherless or motherless orphans, military training, etc.

The Schneider Schools have come to be regarded as real prototypes for the training of engineers, foremen and workmen.

Thanks to the encouragement afforded by Monsieur Eugène SCHNEIDER for thrift, and thanks also to the credit opened for the benefit of employees, the workmen are now the owners of a great number of houses to which a garden is generally attached. Prior to its establishment by French legislation, a pension system was originated as long ago as 1877, and Monsieur Eugène SCHNEIDER has since introduced a number of improvements and developments therein.



Monsieur Eugène SCHNEIDER

Iron-master, President of the Iron and Steel Institute
Honorary President of the Comité des Forges de France

Monsieur Henri Paul SCHNEIDER

(who died gloriously on the Field of Honour)

Monsieur Jean SCHNEIDER

Monsieur Charles SCHNEIDER

ACHIEVEMENTS OF THE FRENCH ENGINEERING AND SHIPBUILDING FIRM, SCHNEIDER & C^IE DURING THE EUROPEAN WAR OF 1914-1918

AT the beginning of hostilities in 1914, the Schneider Establishments, on account of their importance, extensive experience in metallurgy and in artillery construction, were the foremost producers of steel in France, and the leading manufacturers of the various materials and ammunition which became more and more necessary as the war progressed.

In order that the true value of the pre-eminent part played by the Schneider Establishments during the war may be fully appreciated, we take this opportunity to outline comprehensively the principal directions in which the activities of this great Company were exercised.

I. COOPERATION OF MESSRS. SCHNEIDER & C^IE IN INCREASING THE PRODUCTION OF CAST-IRON AND STEEL FOR THE NEEDS OF NATIONAL DEFENCE

THE cooperation of Messrs. Schneider & Cie in increasing the production of cast-iron and steel for the National Defence was shown by the transformation of their processes of production, by the extension of existing works, by the erection of additional steel-making plants, and by bringing the production of steel for shells in the numerous engineering plants of France and other countries up to the correct standard.

EXTENSION OF THE PLANTS OF MESSRS. SCHNEIDER & C^IE

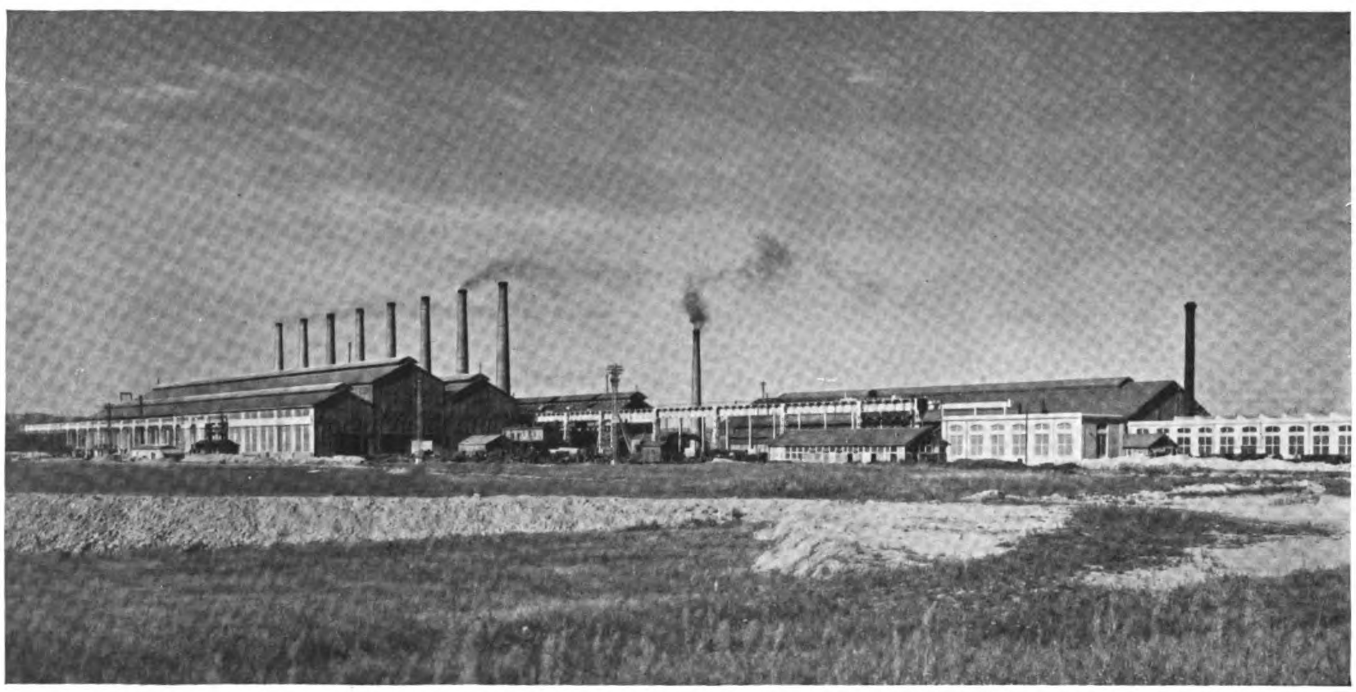
In the early spring of 1915, when Messrs. Schneider & Cie, themselves, were having very important orders of steel for shells carried out abroad, to which we presently will refer, they decided to increase French production by every possible means, using the equipment already existing in their works as far as labor and raw materials would permit, also by building new steelworks. From

the beginning of the war, the Schneider's Thomas Steelworks of Le Creusot had ceased operating. The enemy's invasion of the Briey Basin, where Le Creusot Plant obtained its supplies of Thomas cast-iron ore, prevented any consideration of the resumption of the production of Thomas Steel.

Messrs. Schneider & Cie, in consequence, transformed their Plant for the production of Bessemer Steel, and in the middle of 1915, carried out experiments with a view to using Bessemer Steel in the manufacture of projectiles. The tests proved very satisfactory and, since that time, a very important proportion of the steel produced by the Schneider's Bessemer Steelworks at Le Creusot has been used for that purpose. The results were made known to the French Metallurgical Companies, and the successful method developed by Messrs. Schneider & Cie was adopted by other French Steelworks.

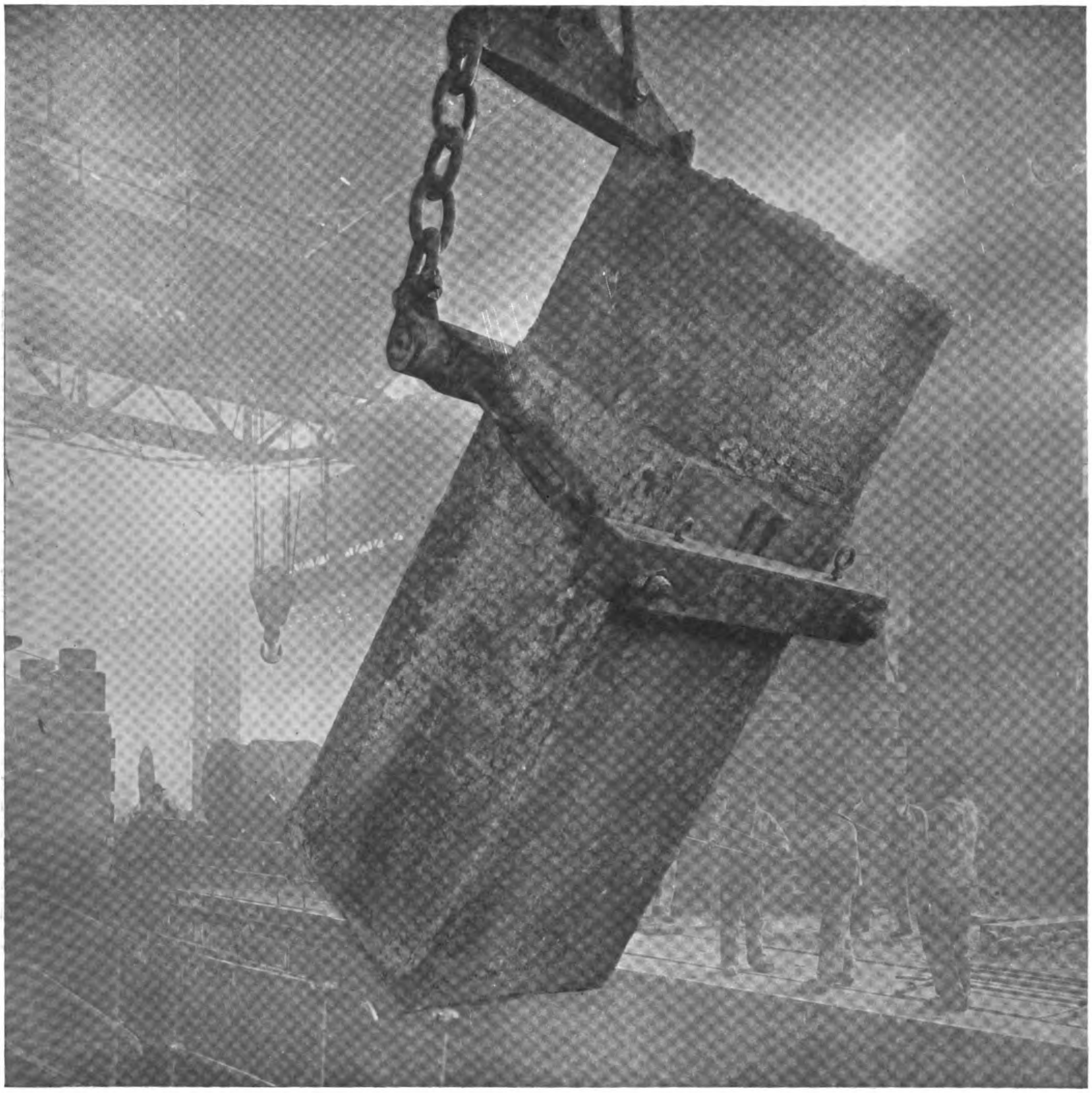
At the end of 1915, the immediate construction of a large steel plant near Le Creusot was decided upon by Messrs. Schneider & Cie. The plant was at first built to contain four 60-ton open-hearth furnaces. The first unit was laid down at Le Breuil at the beginning of 1916, and the first pouring of metal from the furnaces took place on August 3rd, 1916.

As it became more and more necessary every day to produce steel in France, during the year 1916, Messrs. Schneider & Cie decided to increase the number of 60-ton open hearths to five, then to six and finally to add two 30-ton open hearth furnaces. Such an installation made a daily production of more than 1,000 tons of ingots possible by the fall of 1917.



Messrs. Schneider's Large Steel Plant at Le Breuil

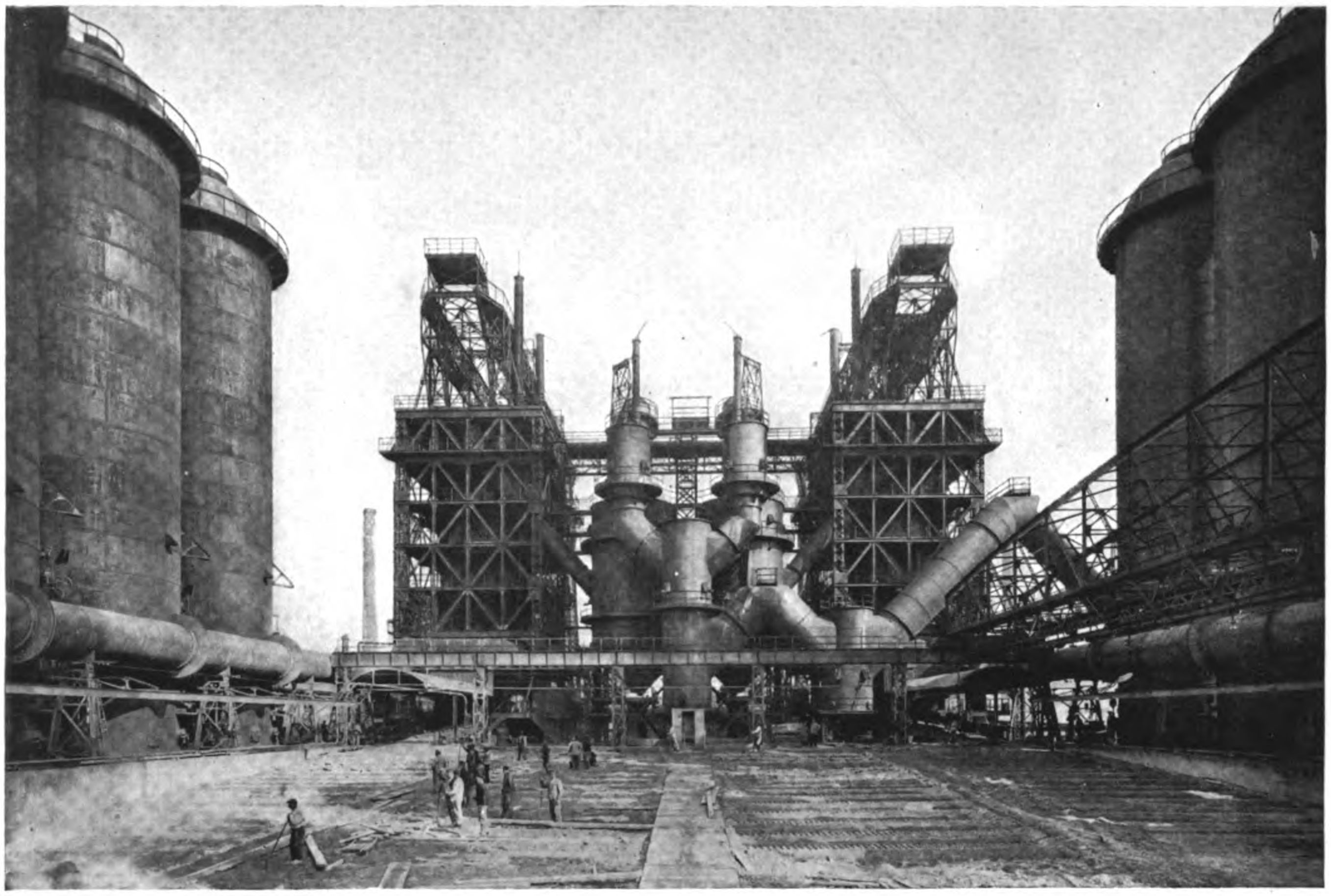
During that period since the need of cast-iron also increased, a new Blast-Furnace was fired at Le Creusot, and another one was put in order in great haste and fired in the middle of 1916.



A 100-Ton Ingot cast at Le Breuil Plant

We can easily appreciate the importance of the increase of steel production at Le Creusot Works, by considering that at the end of 1917, the output of steel for guns was one-thousand per cent. greater than during the first year of the war.

TOWARDS the latter part of 1915, Messrs. Schneider & Cie foresaw the importance that the completion of the Plant of the "Société des Hauts-Fourneaux et Aciéries de Caen," on which work had been suspended at the beginning of the war, would have for the National Defence, and in consequence, entered into negotiations with this Company to resume the enterprise. However, it was not until in 1916 that the erection of this plant with Steelworks appeared imperative enough for France, to render it possible for Schneider's Subsidiary—the "Société Normande de Métallurgie"—to obtain the necessary authorization for the completion of the Caen Plant, which now consists of:—



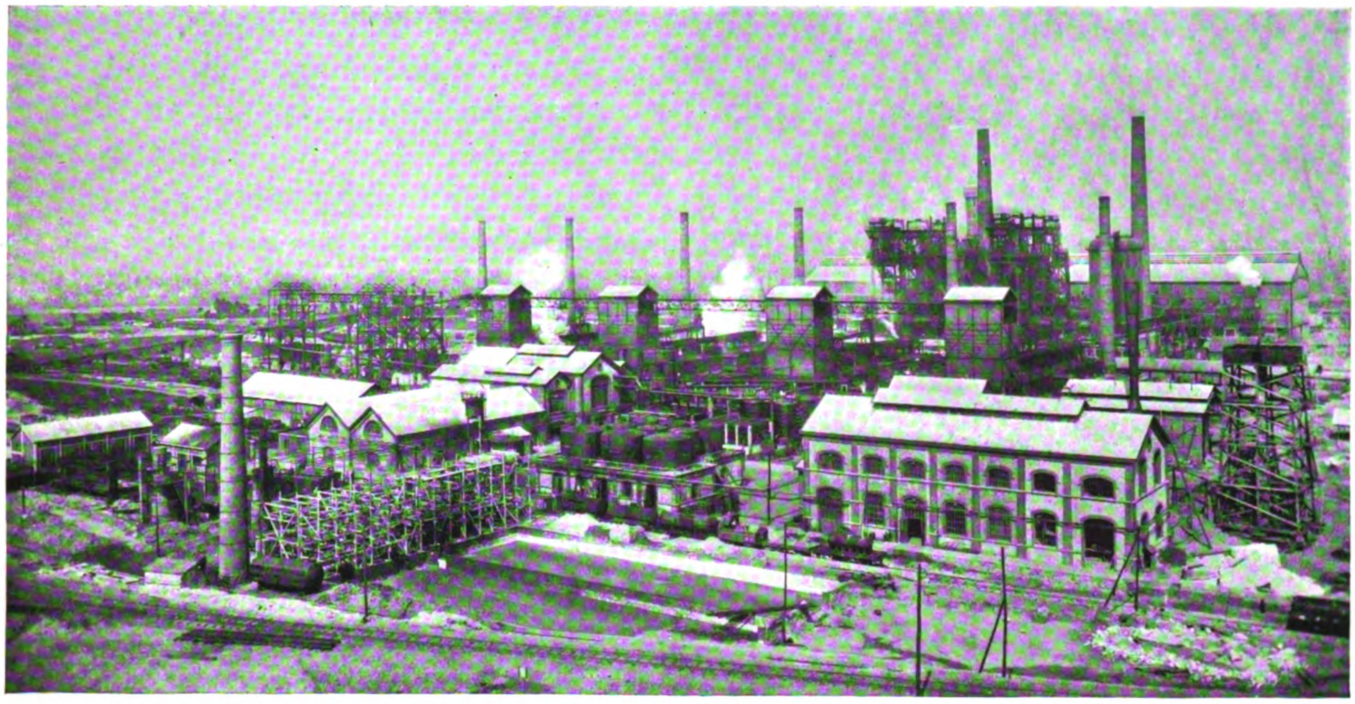
Front View of Two Blast Furnaces at Caen Plant

Two Blast Furnaces each capable of producing 400 tons of pig-iron per day.

Six batteries of Coke-ovens capable of producing 540,000 tons of coke annually, and furnished with all installations necessary for the recovery of the by-products.

Five Open-Hearth Furnaces each of 30 tons, capable of producing annually 120,000 tons of ingots.

Three Thomas converters capable of producing 250,000 tons of ingots annually.



Coke-Ovens at Caen Plant

Two Rolling-Mills capable of producing annually—the one 240,000 tons of rails, channels, beams and angles, and the other 50,000 tons of small sections.

The different departments of this great plant were completed in 1917, and at the beginning of 1918.

PRODUCING THOROUGH STANDARDIZATION IN THE MANUFACTURE OF STEEL FOR SHELLS IN FRENCH AND FOREIGN PLANTS

FRENCH PLANTS. When the metallurgical plants of Central France were resuming their activities, Messrs. Schneider & Cie put at their disposal all the information that they had acquired by experience concerning the production of shell-steel. For instance, they agreed to assist plants that had never produced shell-steel before, in getting their supply of raw material, and also to send them their expert engineers and foremen to instruct their personnel.

FOREIGN PLANTS

AMERICA. At the beginning of 1915, Messrs. Schneider & Cie believed that it would be possible to utilize for National Defence a part of the enormous productive capacity of the various American steel plants, by introducing in those plants their process for the production of steel for shells.

A mission formed of engineers of the Schneider Company was sent to the United States in March, 1915. With its cooperation, various plants of the "United States Steel Corporation," and "Lackawanna Steel Corporation," undertook the making of this steel. In spite of the difficulties to be solved, they were able in a short time to produce good shell-steel under Schneider specifications, and contracts were signed for a very large tonnage which Messrs. Schneider put at the disposition of the French Government.

Relying on these available quantities of metal, the first great program for the manufacture of heavy artillery shells was decided upon and begun in France. Also, when the French Official Mission began to buy steel, its technical task was very much facilitated by the previous work accomplished by the Engineers of Messrs. Schneider & Cie.

ITALY. At the beginning of the hostilities, Messrs. Schneider & Cie had placed contracts for shell-steel with Italian plants for their own account and for the account of the French Government. In the middle of the year 1915, their technical Mission in Italy was given authority by the French Government to technically supervise the fulfillment of the contracts which the latter had placed directly with Italy. The work of this Mission ended in 1916, Italy requiring its own metal for ammunition when she entered the war.

RUSSIA. Since the beginning of the hostilities, Messrs. Schneider & Cie built in Russia, as part of a firm having had close business relations with them before the war, an open hearth and a crucible-steel plant.

Furthermore, during 1915, their engineers visited a certain number of Russian metallurgical works, and furnished all the necessary information to enable them to attain the correct standard in the production of shell-steel.

ENGLAND. At the beginning of the war, Messrs. Schneider & Cie made a few purchases in England where the French Government bought very large quantities of steel.

Towards the end of 1915, the purchases made by the French Mission seemed insufficient to cover the needs of steel for shells; so Messrs. Schneider & Cie, following a conference held in London with the principal representatives of the English metallurgical plants, and in accordance with the French Government, put at the disposal of the French Mission in London a number of their steel specialists or technical advisers, in order to insure the proper production of the steel directly purchased by the French Government, particularly in the Welsh steelworks which, by the way, offered possibilities of much greater output.

RECOVERY OF THE BY-PRODUCTS DERIVED FROM DISTILLATION OF COAL IN CONNECTION WITH PRODUCTION OF EXPLOSIVES

BEFORE the mobilization, the coke-ovens at Le Creusot included a plant for a limited recovery of tar and ammonia.

Answering the call of the French Minister of Explosives, Messrs. Schneider & Cie undertook in 1915 the building of another recovery plant, with a view to collecting in a raw state all the by-products derived from the distillation of coal required by the manufacturers of explosives. This was done, not only in Le Creusot plant, but also in the important subsidiary established by them at Caen under the name of "Société Normande de Métallurgie."

The recovery plant at Le Creusot commenced operating at the end of the year 1915, and the Société Normande recovery plant in 1917. Together they furnished monthly to the Explosive Department important quantities of pure benzene for the fabrication of synthetic phenol, pure trinitotoluene for T. N. T., naphthalene and phenol.

II. SCHNEIDER ARTILLERY

IMPORTANT ROLE OF SCHNEIDER GUNS ON ALL THE FRONTS

AMONG the various models of guns which, have been in service on all fronts, those of Schneider design have played a highly important part during the war for Liberty. In service simultaneously in the French, American, Belgian, Serbian, Roumanian, Italian and Russian Armies, they have valiantly surmounted the most severe trials: such as, for instance, being moved over shell-torn ground and through seas of mud, or being subjected to intensive firing without cleaning-up and proper up-keep, or being handled by inexperienced personnel, etc.

Now that victory has been attained, it might be interesting to know something about a system of artillery which has accomplished the greatest performance possible, that of lasting service in a war which surpassed all that history has hitherto recorded.

Prior to the war this design of weapon had already earned world-wide renown. Monsieur Eugène SCHNEIDER, thanks to the unceasing efforts of his Establishments during the last twenty years, has succeeded in creating in its entirety a complete quick-firing system of artillery ranging from the 3-inch gun to the 520 m/m (20.5″) gun, which even before the Great War, was always considered as belonging to a far higher class of ordnance units than that made in other countries.

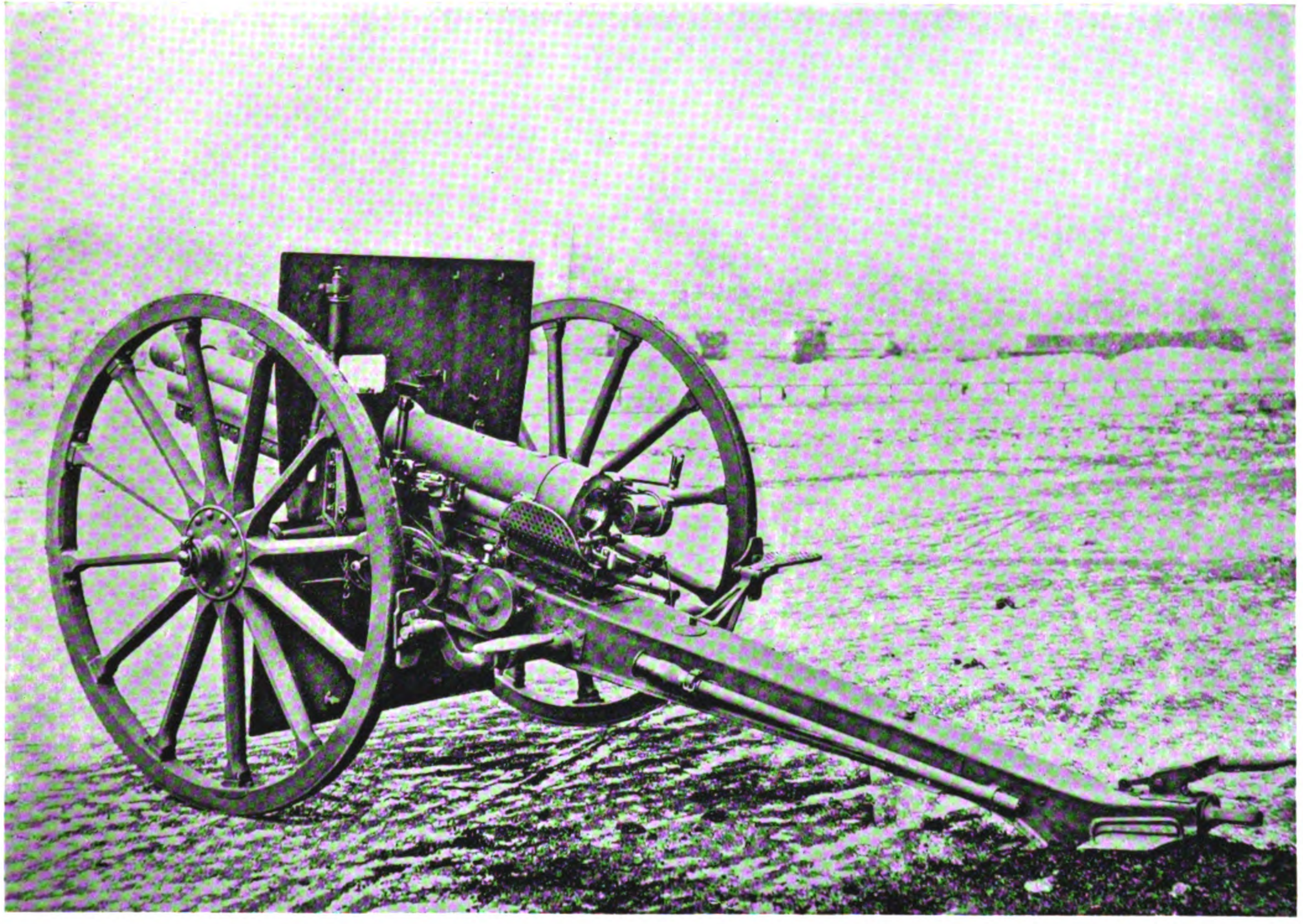
The various pieces of ordnance of Schneider design have certain general characteristics in common, and display despite inevitable differences in detail, an evident and close similarity that facilitates rapid acquaintance with the material and its maintenance in good working order.

It is impossible to give the exact number of Schneider guns supplied to the French and Allied Armies. We can only say that the pieces of ordnance manufactured by the Schneider Works represent about 75% of the total production of guns used by the French Forces.

THE SITUATION IN 1914

THE Russian Government after severe tests had adopted the following series of Schneider Ordnance namely:—3″ mountain-gun; 3″ field-gun; 4.2″ long field-gun; 6″ long caliber gun; 6″ and 8″ howitzers; 9″ mortar firing on wheels and the 11″ mortar with platform mount.

Serbia, Roumania, Bulgaria and Greece have successively adopted the Schneider 120 m/m (4.7″) and 150 m/m (5.9″) howitzers, after having previously been supplied with the Schneider mountain-guns and field-guns; all these suc-



The 75 m/m Schneider Gun Model 1912

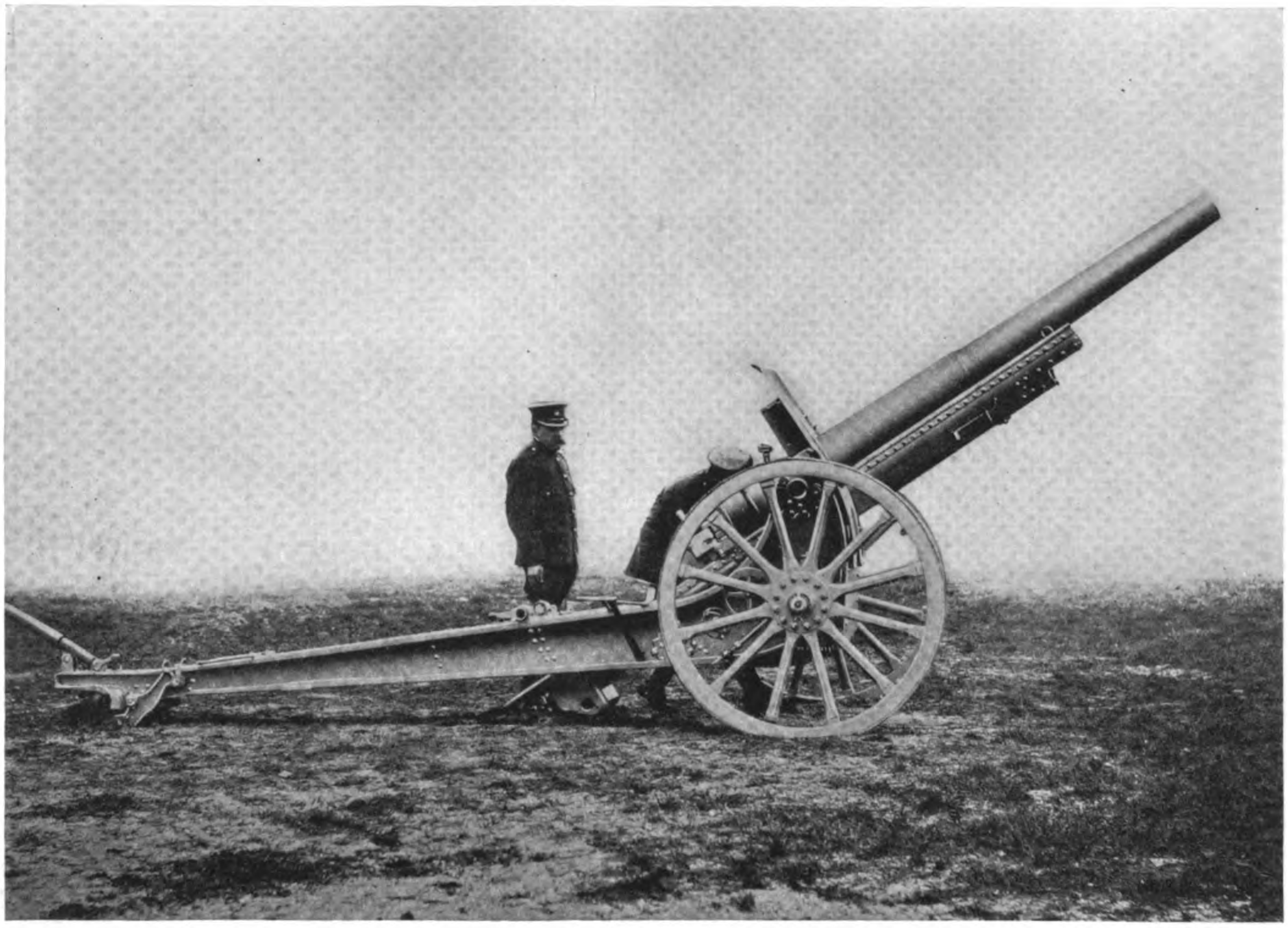
cessfully withstood the trials of the Balkan Wars, in the most mountainous districts, where the condition of the roads was particularly bad.

Furthermore, the Italian Artillery put into service a Schneider mortar of 26 c/m (10.2″) firing on wheels, and at the same time provided their 21 c/m (8.2″) mortar with a Schneider carriage.

Finally, the French Ordnance Department breaking away from the rigid rule to which it had previously adhered, of always establishing its own models of armament, adopted the 75 m/m Schneider Gun Model 1912, the 105 m/m

(4.2") Schneider Gun Model 1913 and the 280 m/m (11") Schneider Mortar Model 1914.

In short, when the war broke out in 1914, Messrs. Schneider & Cie's cooperation was requested by the French Ordnance Department and by several of the Allied countries; they were consequently compelled to increase considerably the productive power of their workshops, and they lost no time in meeting the situation after having made the necessary preliminary studies on the subject.



The 105 m/m Schneider Gun Model 1913

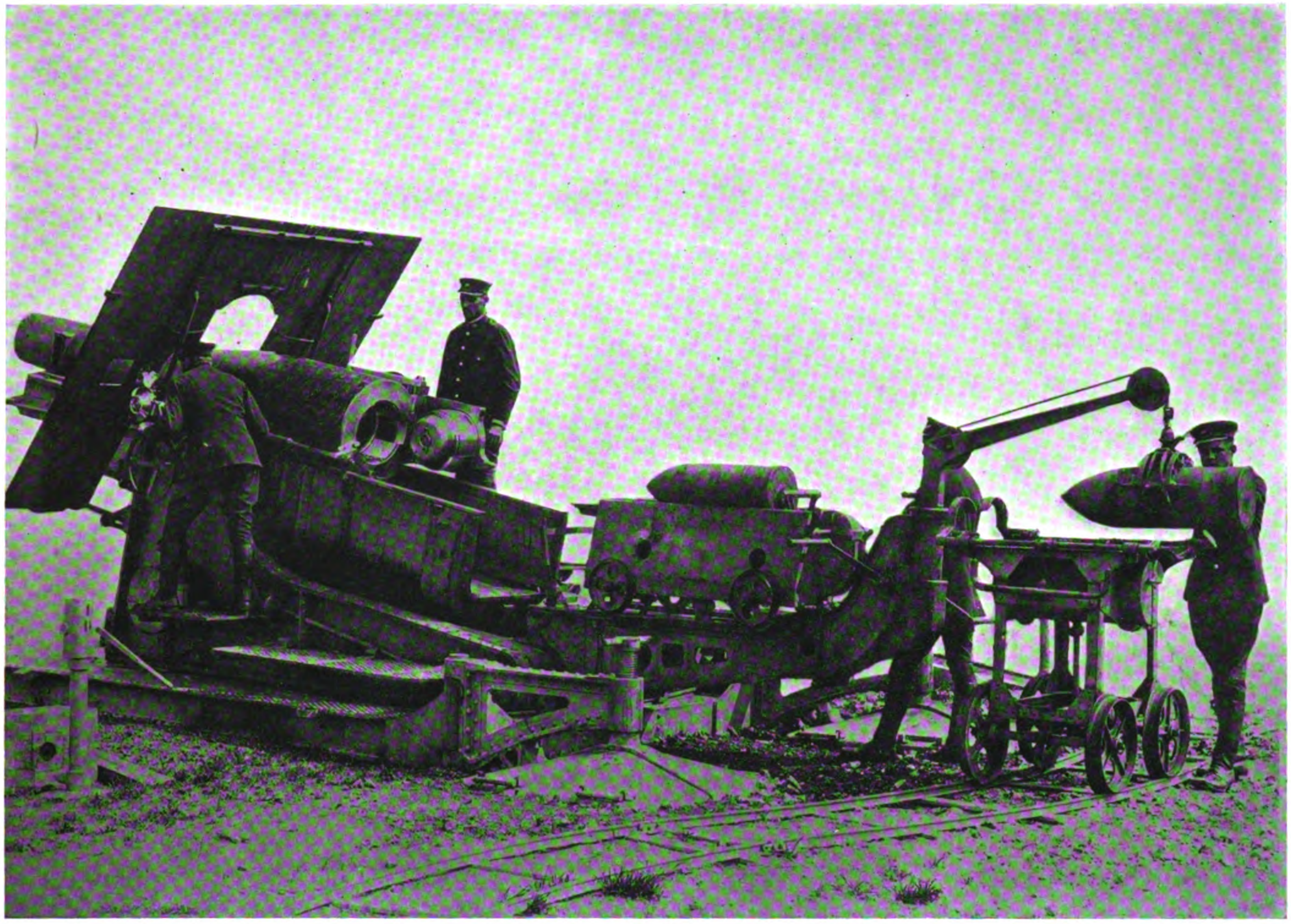
FIRST DEVELOPMENTS DURING THE WAR

AFTER the memorable days of the Battle of the Marne in September 1914, the great need of intensive artillery manufacture became evident to everyone. The production of the Schneider 105 m/m guns and 280 m/m mortars was accelerated, and the 105 m/m guns started their long career at the front almost immediately. With a range of 12 kilometers (13,600 yards) and a relatively low weight of 2,350 kilos (5,200 lbs.) for the gun in battery, the 105 m/m guns were in great demand wherever the operations assumed even the appearance

of open warfare. They played a very important role during the last months of the struggle.

280 m/m MORTAR. Regarding the 280 m/m mortar, its value became fully apparent in 1915, at the time of the preparation for the French attacks in Artois and Champagne.

Owing to its very reliable action, and to the fact that it can be dismounted into four-wheeled sections, thereby making it exceedingly mobile, it very soon acquired the reputation of being an excellent weapon.



The 280 m/m Schneider Mortar Model 1914

It was particularly adapted for destroying shelters, command posts, and fortified points owing to its 205 kilos (455 lbs.) projectile and its range of 12,200 yds.

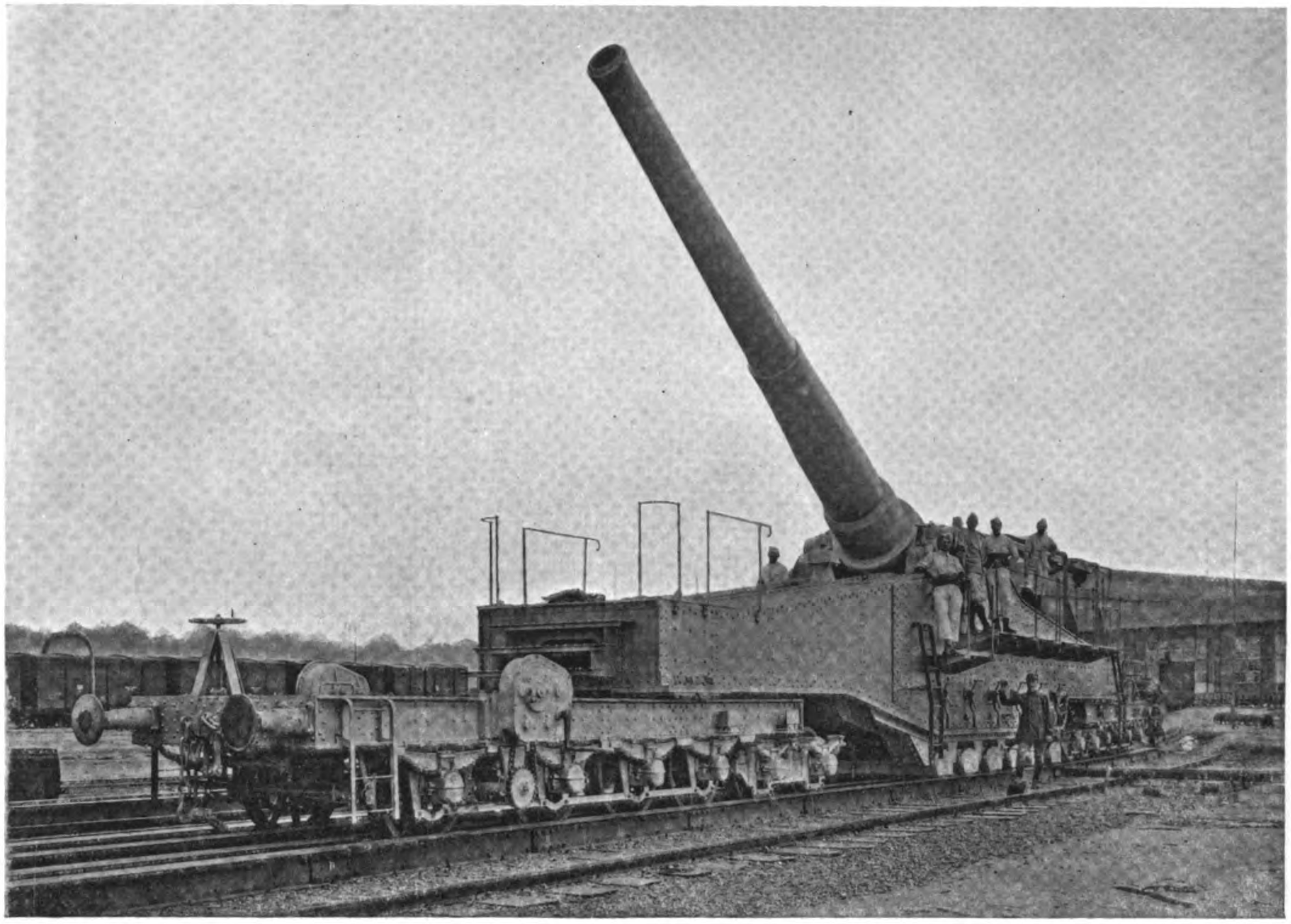
It was not surprising that this model was adopted by the U. S. War Department and manufactured in America. The caliber was changed from 280 m/m to 240 m/m; otherwise the design was almost identical.

RAILWAY ARTILLERY. The necessity of combatting the tremendous amount of heavy artillery which the Germans had provided led to the mounting

on railroad cars, of a number of naval and coast-defense guns which the naval situation made available.

Several 293 m/m (11.6″) Schneider mortars and 200 m/m (8″) Schneider guns were also mounted in this manner.

For the installation of big coast and naval guns, Messrs. Schneider devised a sliding-railway mount which showed remarkable qualities in service. In this system the carriage is extremely simplified inasmuch as it has an elevating mechanism only. The lateral aiming of the gun is accomplished by displacing



The 305 m/m Gun on Schneider Sliding-Railway Mount

the whole railway mount on a curved spur connected to the main track. The railway mount rests by means of cross-beams on firing rails placed parallel with the track, and slides back on these rails when the piece is fired.

The operations necessary to put the railway mount on wheels, or vice versa, to rest its weight on the firing rails, are rapidly and easily accomplished by means of jackscrews connected with the cross-beams.

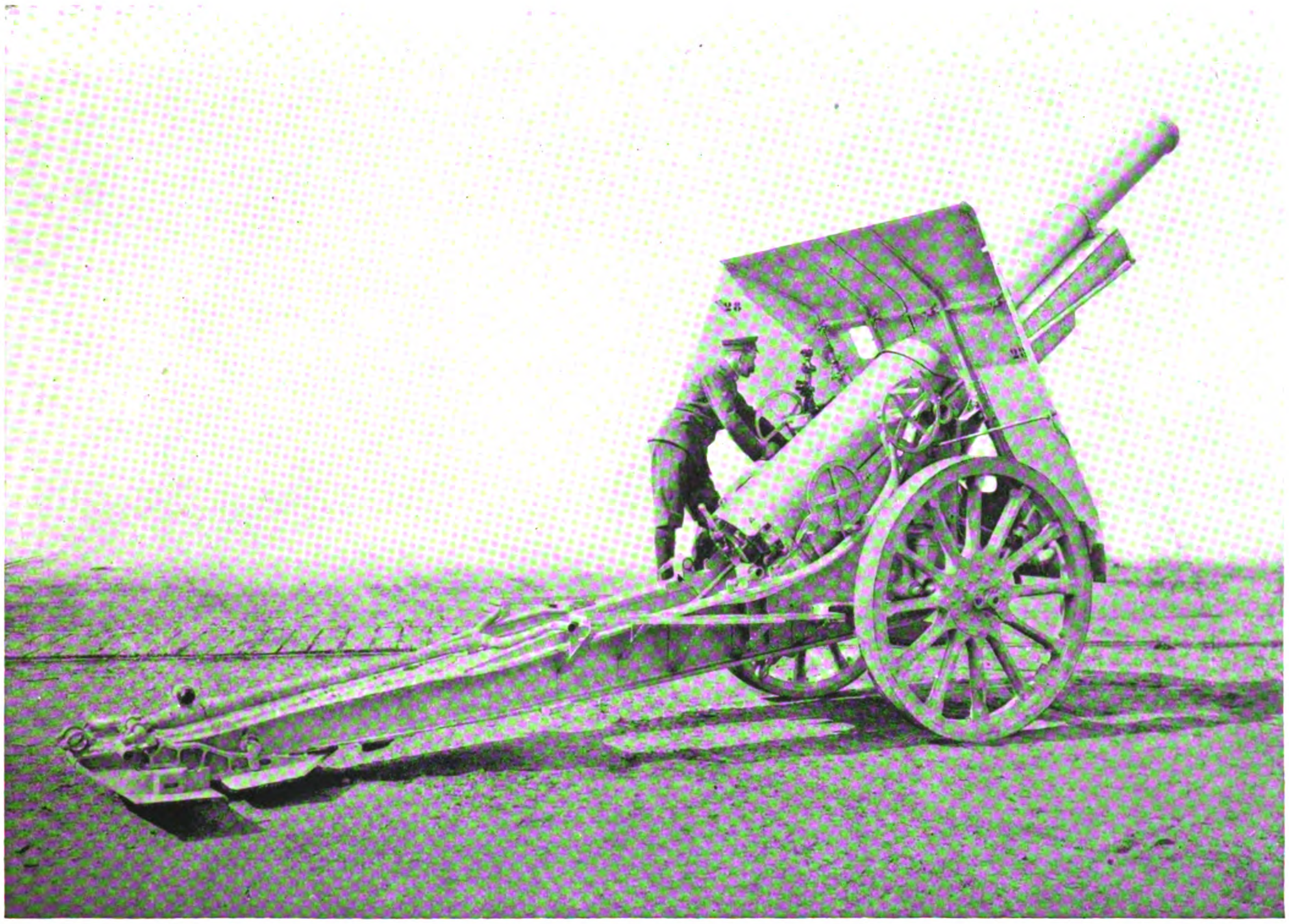
Moreover, this method makes possible the rapid removal of the material when exposed to dangerous fire. The 305 m/m (12″), 320 m/m (12.6″), 340 m/m

(13.4″) and 370 m/m (14.6″) guns mounted in this manner have always worked very satisfactorily.

We may mention that the American Ordnance Department adopted this system of sliding-railway mount for their 10″ guns.

THE ERA OF THE 155 m/m CALIBER

TRENCH warfare, after the battle of the Marne, emphasized the vital importance of having, in addition to powerful long range guns, and field-guns suited to barrage work, a medium caliber weapon which could be charged with the



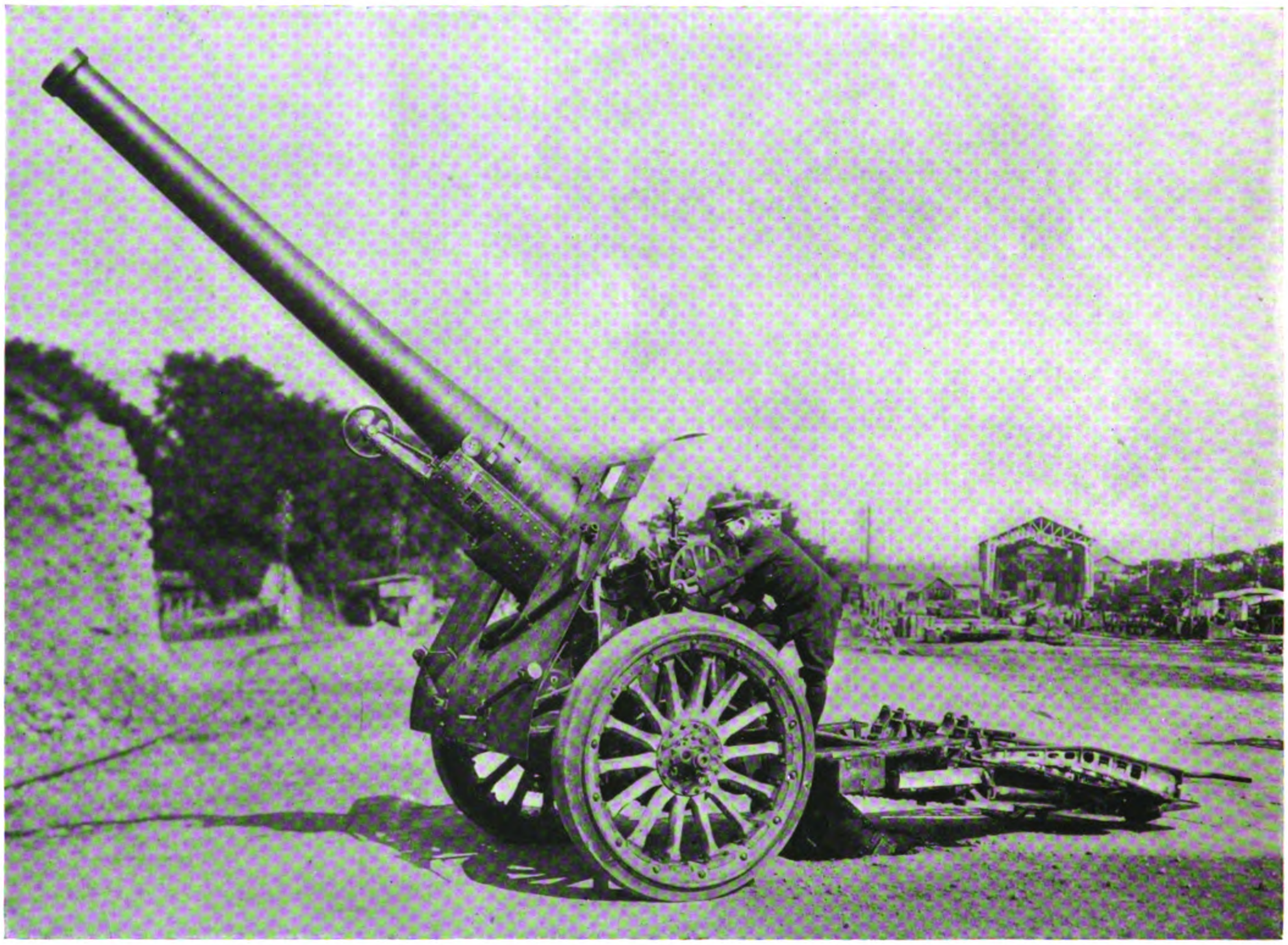
The 155 m/m Schneider Long Caliber Model 1877-1914

destruction of the normal enemy defenses and with counter battery work. The 155 m/m caliber with its projectile of 43 kilos (95 lbs.) seemed to possess the necessary requirements.

155 m/m LONG MODEL 1877-1914. The first step taken toward establishing such medium caliber material consisted in mounting the long de-Bange gun model 1877 on a Schneider carriage. This design had been made before the war.

In this way a gun was obtained having a range of 13.600 kilometers (15,000 yds.) weighing 6 tons in battery, and transportable in two sections, each weighing less than 4 tons.

155 m/m LONG MODEL 1917. The 155 m/m Schneider Long Caliber Model 1877-1914 made its appearance at the front in April 1916, and no sooner had it proved its qualities, than it appeared necessary to have a new model with a longer range. Accordingly, the 155 m/m Schneider Long Caliber Model 1917 was designed, constructed and placed in service in the middle of 1917. It was very



A 155 m/m Schneider Long Caliber Model 1917

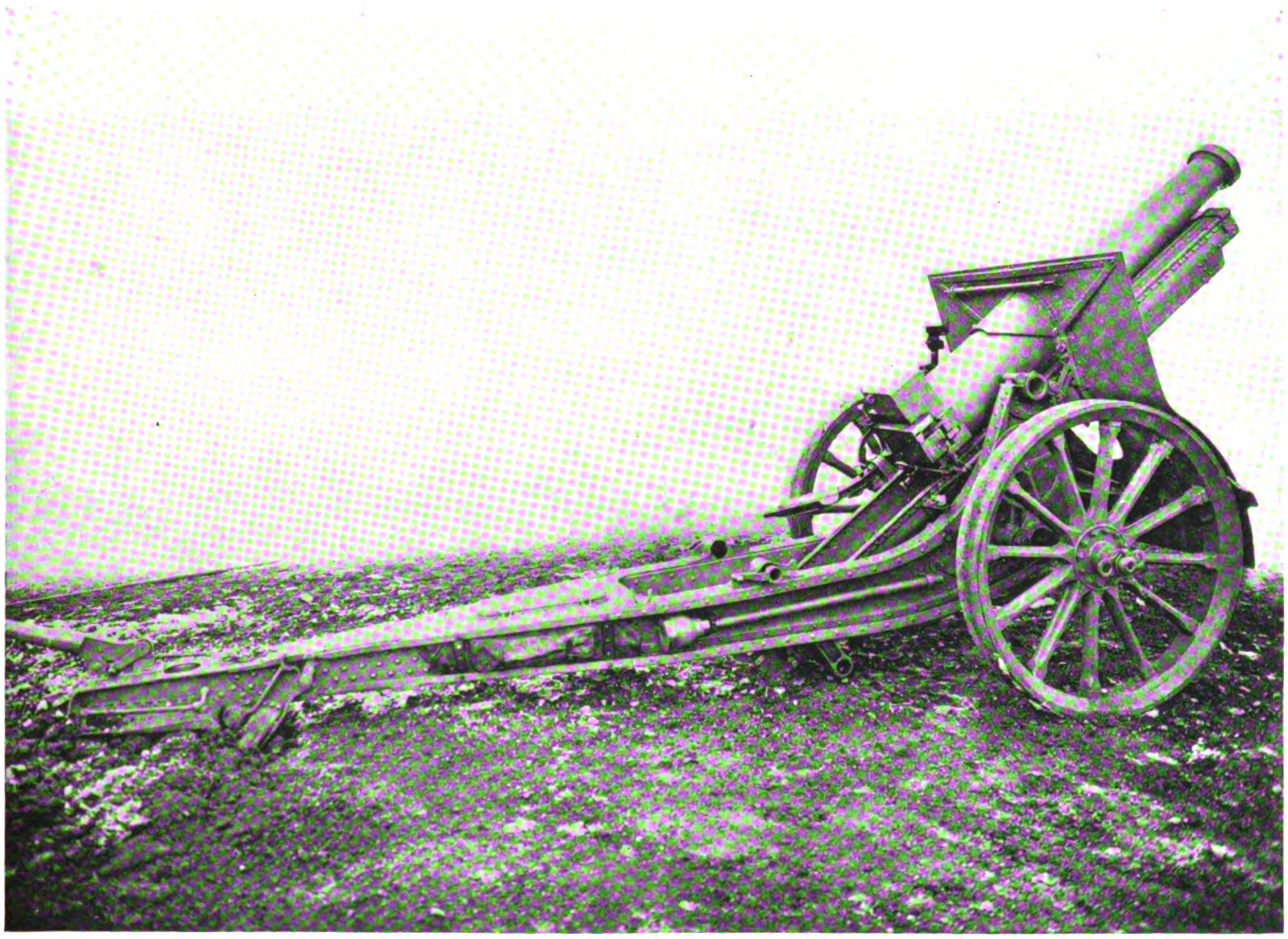
favorably received owing to its range of over 16 kilometers (18,000 yds.), its great accuracy, and its mobility.

155 m/m HOWITZER MODEL 1917. The Schneider model, however, that was most extensively employed was the 155 m/m howitzer. Its construction was begun at the end of 1915. A first model known as 155 m/m Schneider Howitzer Model 1915, entered into action in June 1916. Complete in battery it weighed 3,200 kilos (7,100 lbs.), limbered, 3,600 kilos (8,000 lbs.), and

was drawn by horses. It had a maximum range of 12 kilometers (13,200 yds.), yet it afforded big angles of fall at shorter ranges; the rate of fire attained was 4 rounds a minute.

The howitzer model 1915 used cartridge cases, but later it seemed more economical to use a powder charge in a silk bag, and thus a new model howitzer was brought out, namely the 155 m/m Schneider Howitzer Model 1917, which differs from the earlier model only in its breech mechanism.

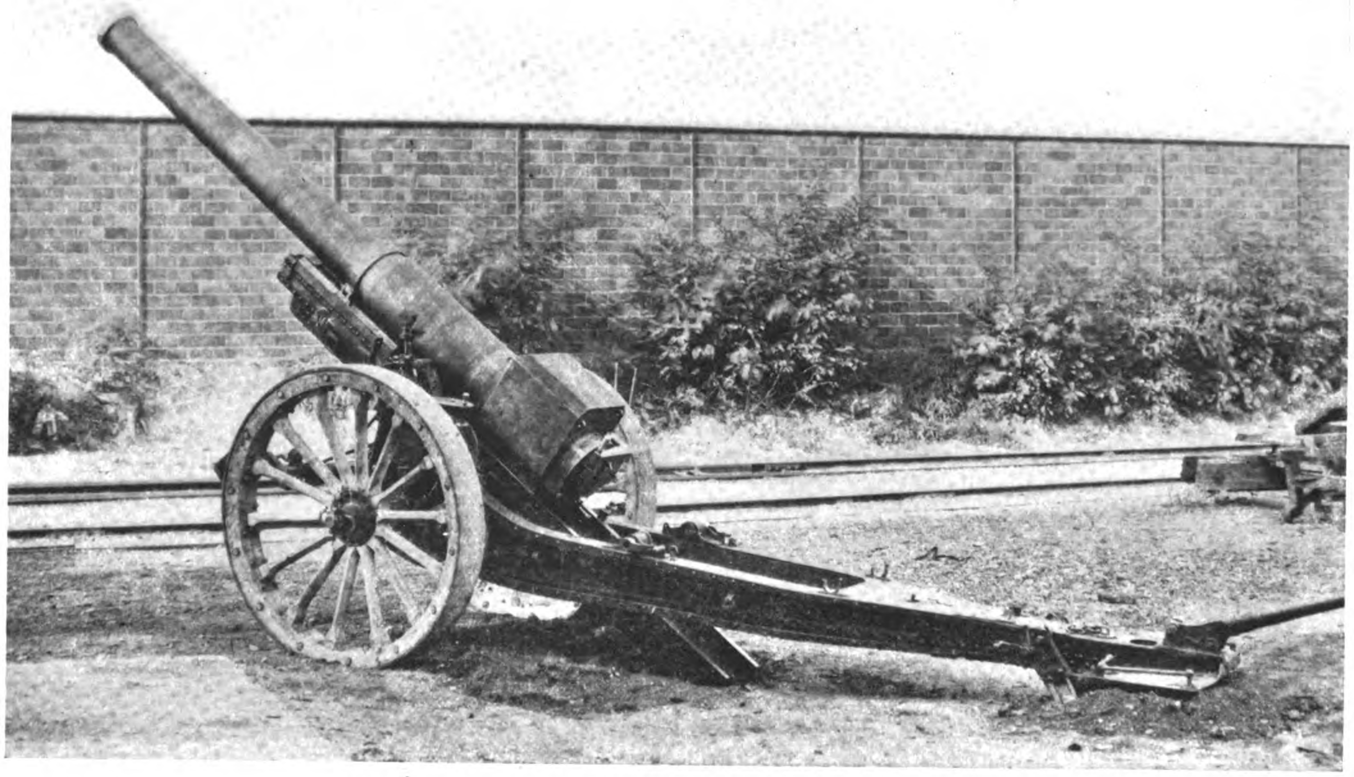
This model 1917 was found to be so efficient that its production was in-



The 155 m/m Schneider Howitzer Model 1917

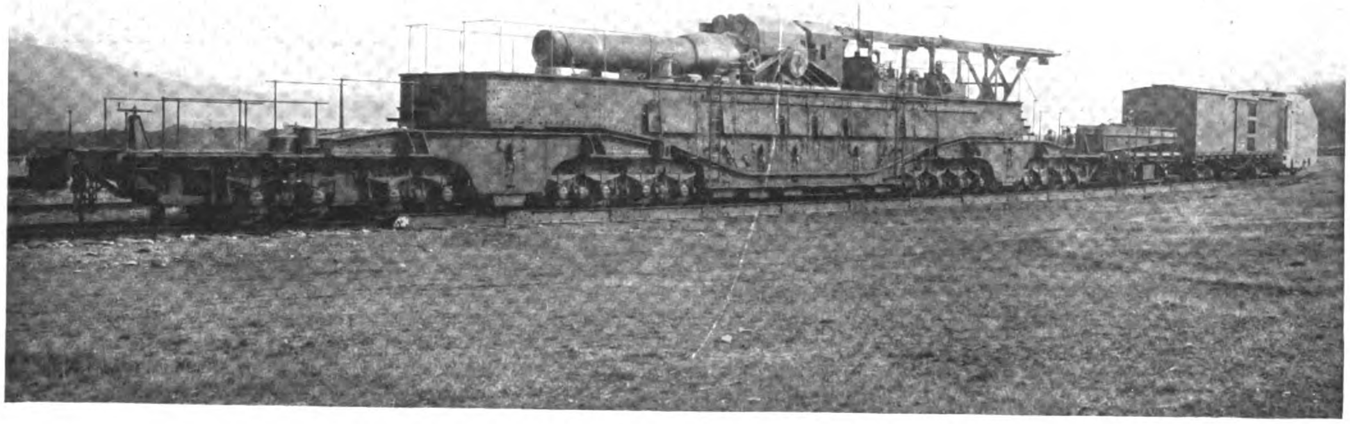
creased by every possible means. It was adopted without modification by the U. S. War Department and constructed in several American plants. To give an idea of the extent of its employment, it is sufficient to say that in 1918 there were 3,000 of these pieces on the French front alone. Moreover, the American Ordnance Department was planning to manufacture a far greater number.

155 m/m LONG MODEL 1918. The mobility of the 155 m/m Schneider Howitzer Model 1917 early in 1918 suggested the employment of a similar material, but with greater range possibilities. The ballistic power of the 155 m/m long caliber



155 m/m Schneider Long Caliber Model 1918

gun model 1877-1914 was selected for this purpose. Thus the 155 m/m Schneider Long Caliber Model 1918 was produced, which is similar to the howitzer model 1917 except that its range is 13.600 kilometers (15,000 yds.).



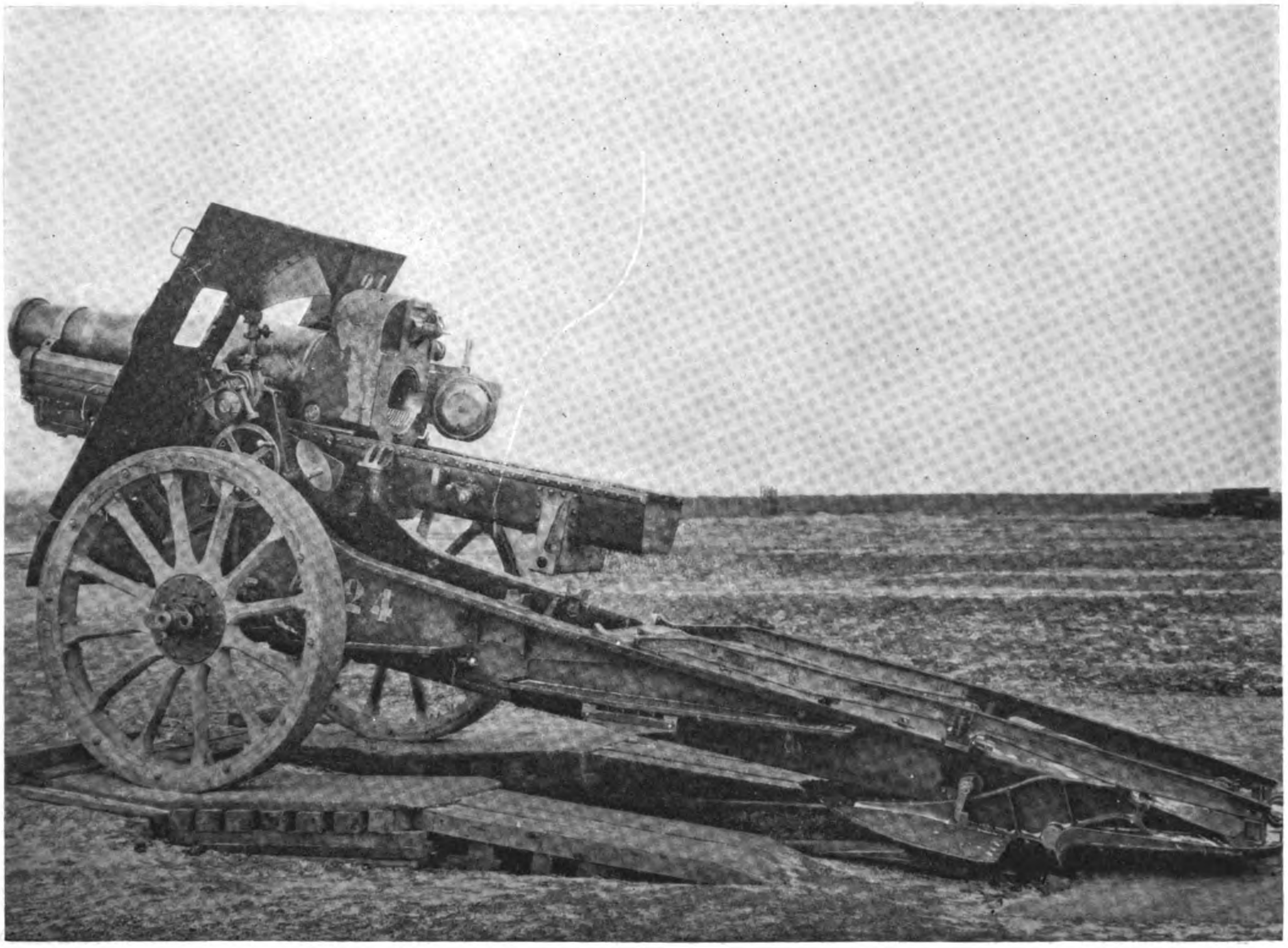
A 520 m/m Schneider Howitzer on Sliding-Railway Mount

520 m/m (20.5") HOWITZER. As soon as the enemy saw his forts and trenches menaced by a powerful and mobile artillery, he erected much stronger defenses, some of which were extremely hard to demolish. It then became necessary to have a few pieces of very large caliber, and toward the middle of 1916, Messrs. Schneider designed and constructed the 520 m/m (20.5") Howitzer, which with its projectile of 1,400 kilos (3,100 lbs.), its explosive charge of 300 kilos (660 lbs.), and its range of 18 kilometers (20,000 yds.), constitutes the most redoutable engine of war that has ever been devised.

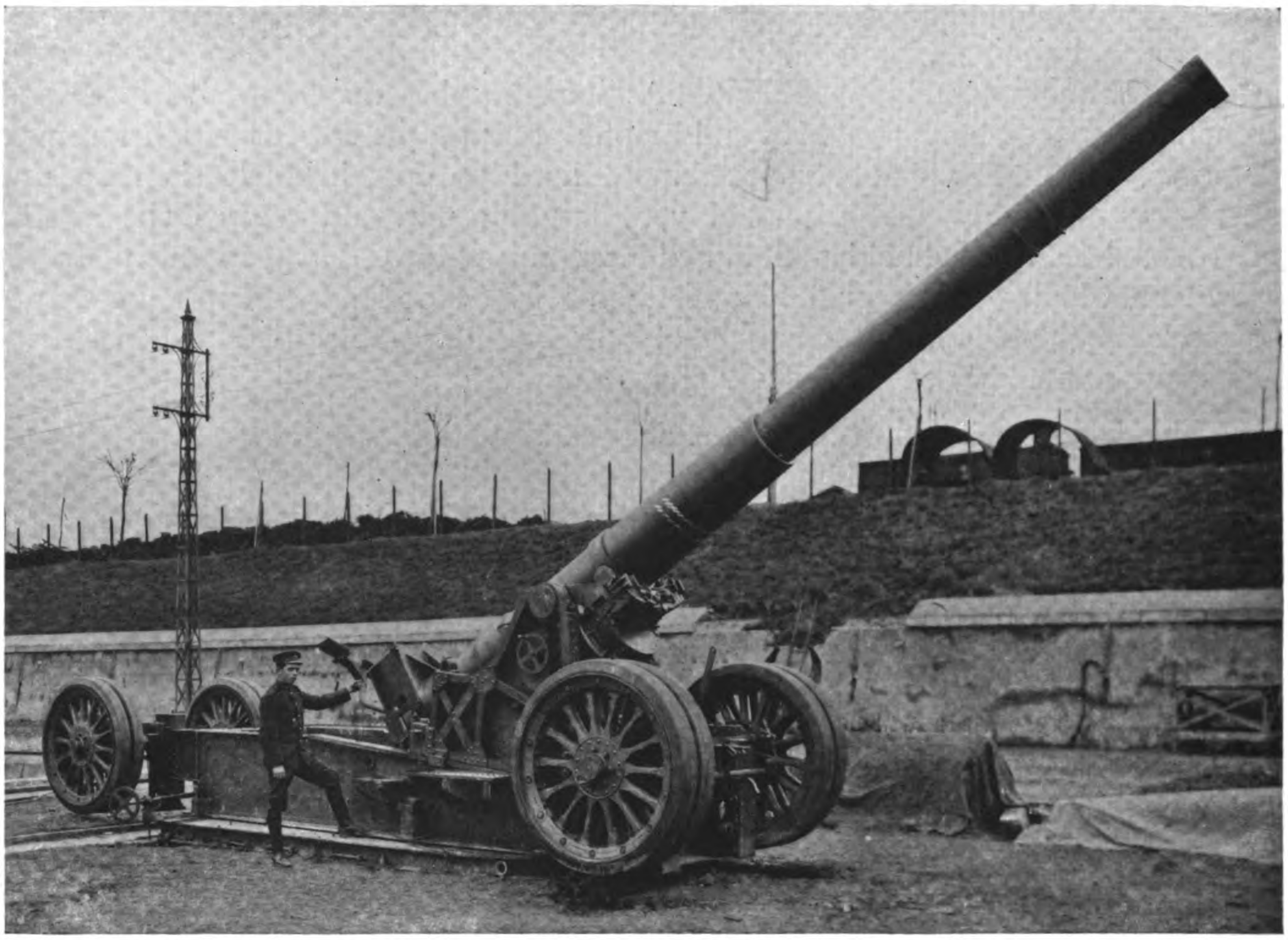
This howitzer is mounted on a sliding-railroad mount.

220 m/m MORTAR. The 220 m/m Schneider Mortar which throws a projectile weighing 100 kilos (220 lbs.) at a distance of 11.5 kilometers (12,800 yds.) was also adopted in 1916. Its weight in battery is 7.5 tons and it is transported in two sections, the heaviest of which weighs 5.5 tons.

220 m/m LONG CALIBER GUN. The efficiency of the 220 m/m shell early suggested the idea of utilizing its destructive power far beyond the range



The 220 m/m Schneider Mortar Model 1916



A 220 m/m Schneider Long Caliber Model 1917

possible with the 220 m/m mortar, with a material still retaining sufficient mobility.

The designing of such a 220 m/m gun with a range of 22 kilometers (24,400 yards) offered many difficulties; nevertheless the construction was begun in 1917 and the first batteries entered into action in 1918.

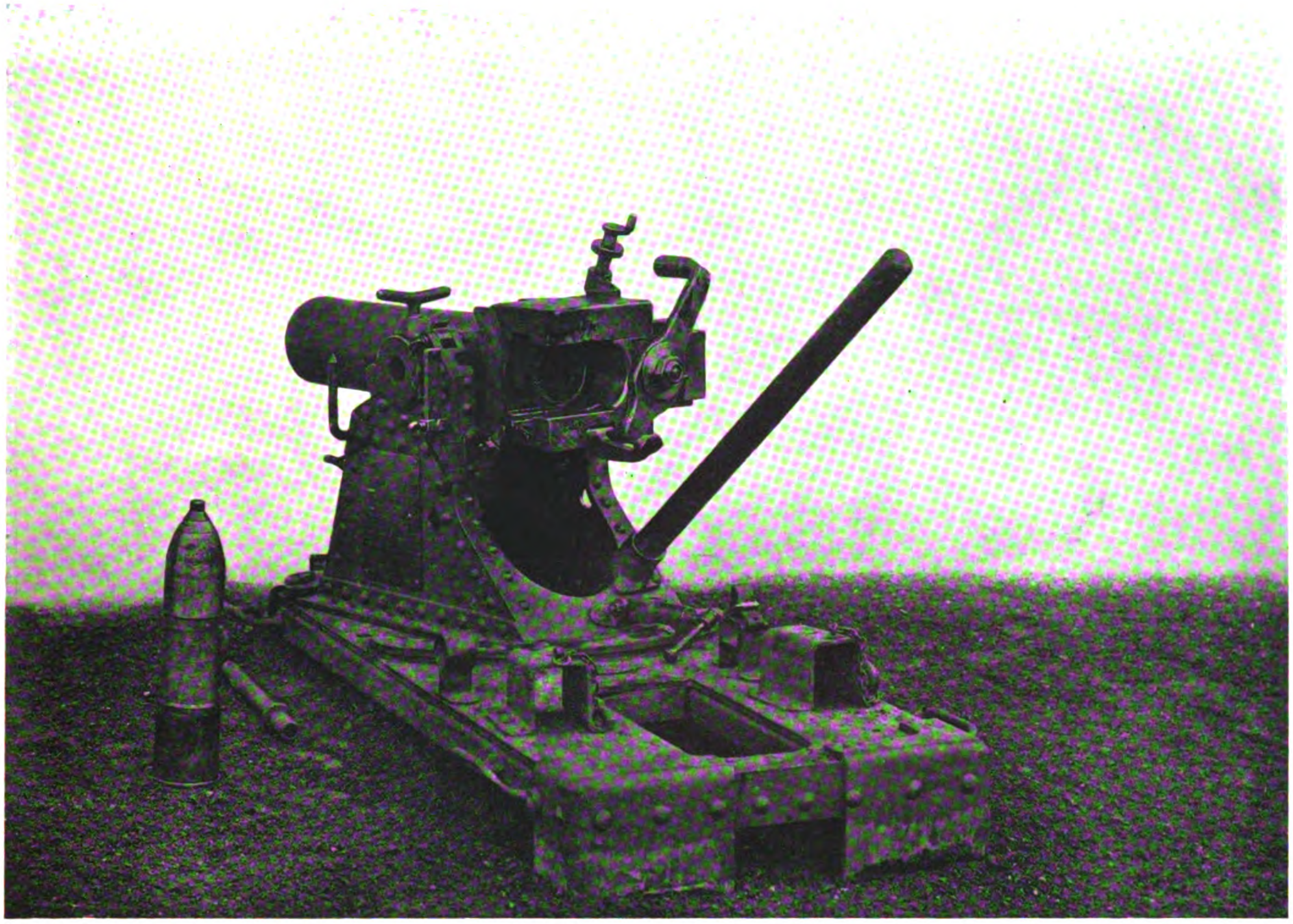
GUNS OF VARIOUS TYPES

IT would take too long to enumerate all the different guns made by the Schneider Establishments during the war; we will mention only:

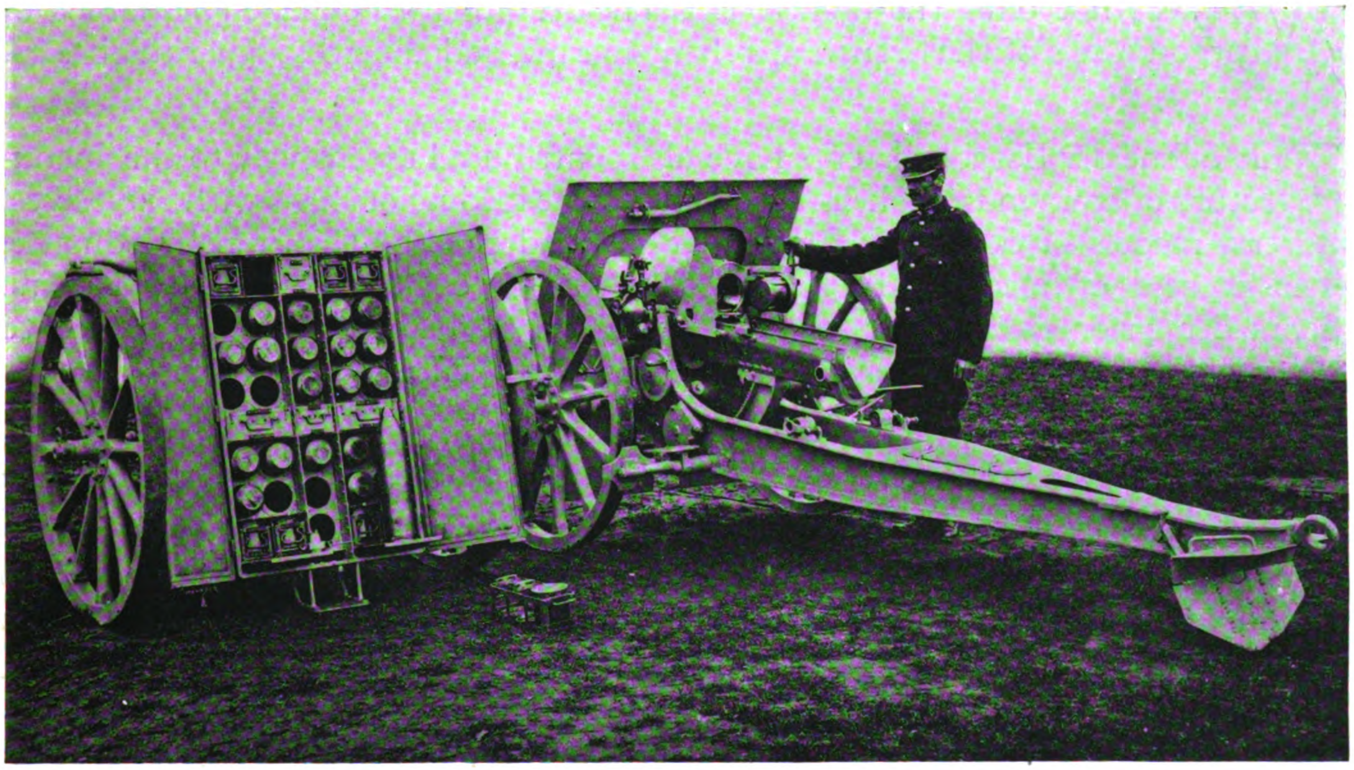
1. The 75 m/m Schneider Trench Mortar, of which 1,000 were put into service along the French front in 1915.

2. The 120 m/m Schneider Howitzer which, after having been in service at the French front was sent to the Salonica front, where it was most successful owing to its mobility and power.

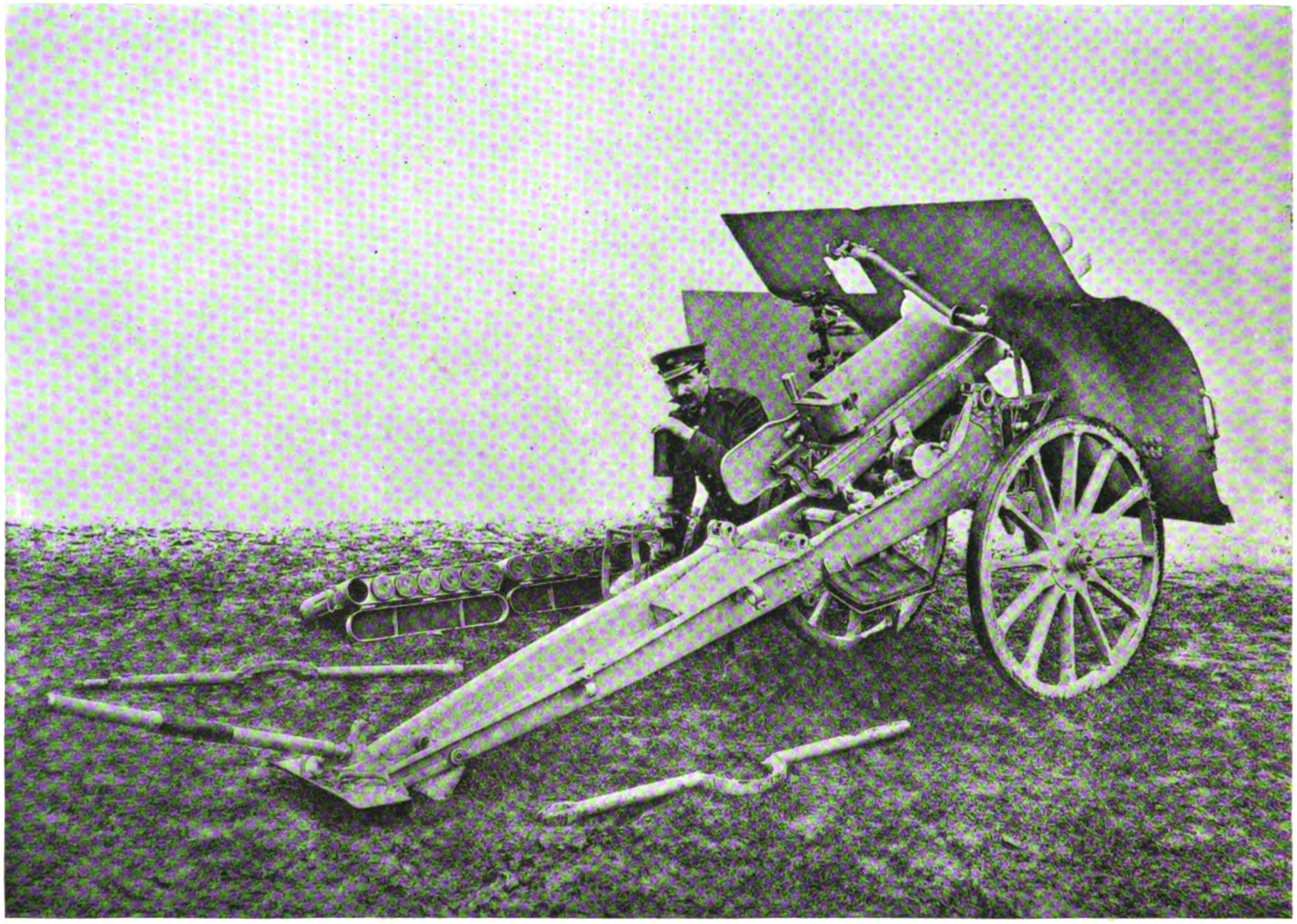
3. The 75 m/m Schneider Mountain Gun with great ballistic power, which was adopted before the war by the Russian, Greek, Serbian and Roumanian Governments, and also proved very valuable at the Salonica front.



The 75 m/m Schneider Trench Mortar



A 120 m/m Schneider Howitzer



The 75 m/m Schneider Mountain Gun

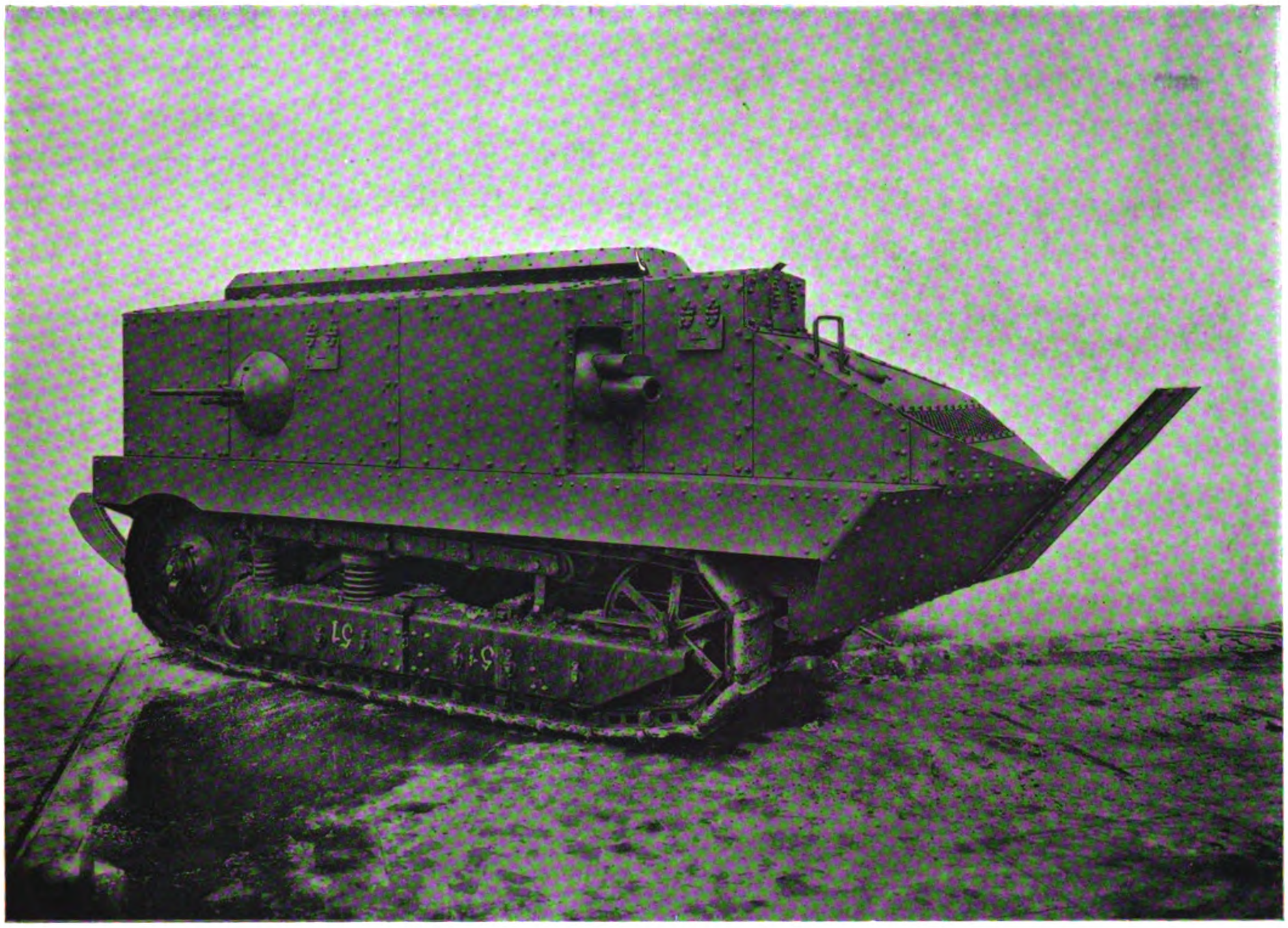
WE must not omit the numerous Schneider guns installed on hundreds of cargo-vessels of the French merchant-marine, and aboard submarine chasers.

THE Schneider Establishments have also contributed extensively to the manufacture of ammunition, shells, fuses, and to the loading of shells with explosives. Several models of Schneider fuses have been adopted by the French Ordnance. The process of loading shells with the special explosive used by Messrs. Schneider prior to the war, called "Schneiderite" has been also employed to a very great extent by the pyrotechnical shops of the French Ordnance.

TANKS. It is also worth while to mention the Schneider Tanks which have played such a great part at the front.

It was during the fall of 1915 that Messrs. Schneider first attempted to design, and soon to develop and construct armored caterpillar cars equipped with armament.

They produced a tank weighing 14 tons, having a speed of 5 miles per hour, and the armament of which was composed of a 75 m/m short-gun located at the right side of the forward end, and two machine-guns, one on each side.



A Schneider Armored Tank

Several hundred of these tanks were built in 1916 and 1917, and were the first to be used at the French front in the spring of 1917, where they rendered the best service.

TRACTORS-TRUCKS. Messrs. Schneider & Cie have also built a great number of combined tractors-trucks each of 3 tons carrying capacity, and capable of hauling a gun at the same time.

LOCOTRACTORS. They have also built many 10-ton locotractors for narrow-gauge tracks, and 15-ton locotractors for the standard gauges.

THE LYON

PANELS OF SCHNEIDE

After the Struggle for Victory

FAIR 1919

ESTABLISHMENTS EXHIBIT

The Work for Peace

At the Lyons Fair in March 1919, Messrs. Schneider & Cie exhibited their products of war and peace. Conspicuous at the entrance of their section were the above two paintings, also the map shown on the cover of this supplement, these illustrations depicting their many engineering facilities in a striking manner.

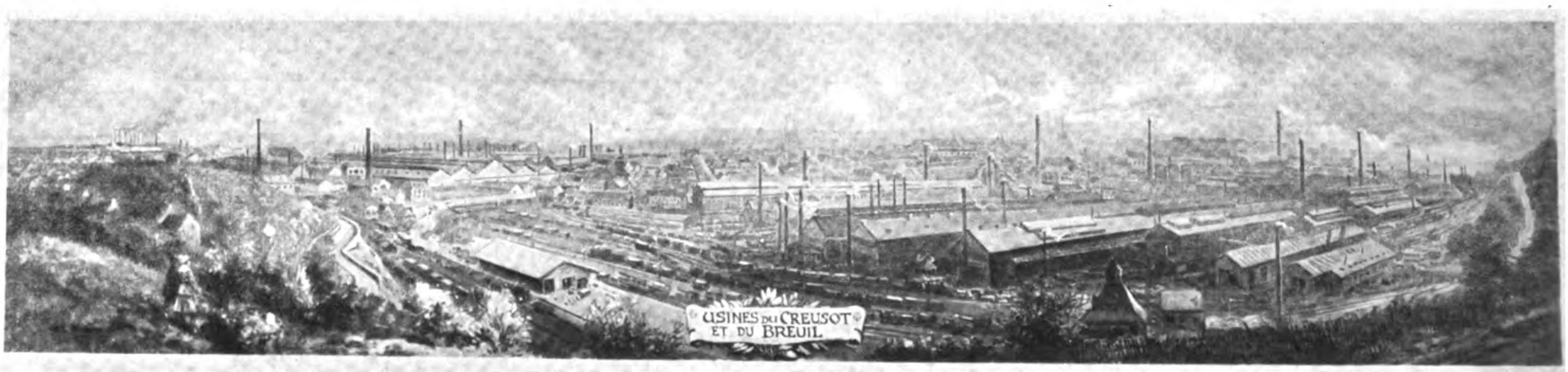
THE SCHNEIDER ESTABLISHMENTS

NOW that the war is over and that victory has come to reward the efforts of more than four years' struggle, the activities of Messrs. Schneider & Cie are directed toward peace-time industries.

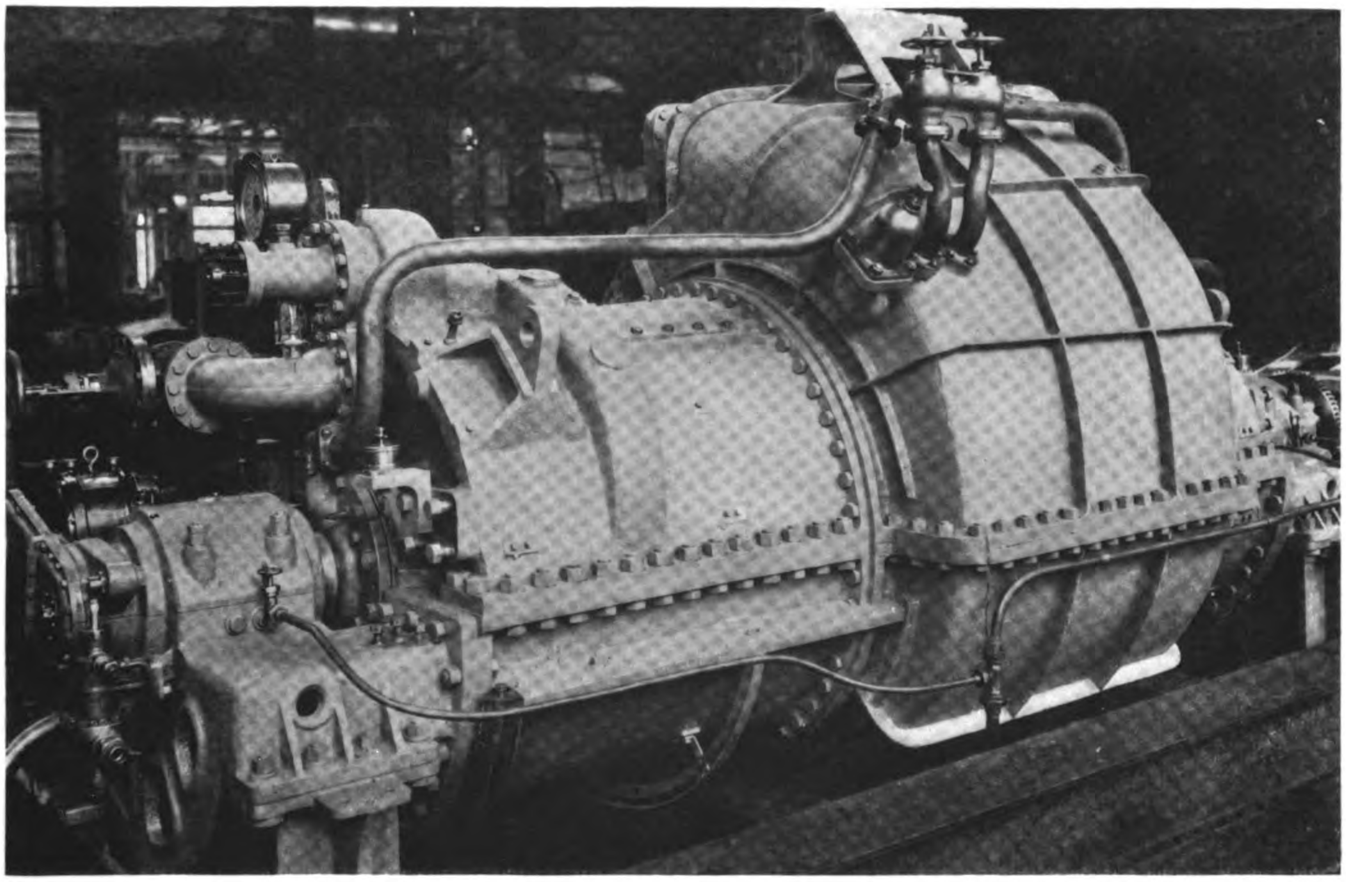
THE SCHNEIDER WORKS now comprise the following Plants:

THE CREUSOT WORKS which consist of a colliery, blast-furnaces,coke-ovens with recovery of by-products, open-hearth plants; forging-shops capable of converting the whole of the steel ingot production into armour-plates, sheets and various sections; moulding-shops for steel, cast-iron and bronze; forging shops for steel parts, uncommonly well-equipped machine-shops for the construction of turbines, motors, locomotives; also for the manufacture of pieces of ordnance, armour-plates, etc.; proving-grounds for testing pieces of ordnance; a laboratory with a radio metallographical equipment, etc.

The moulding-shop for steel castings is numbered among the biggest European shops of this kind. Its products include any kind of pieces, from the smallest up to those weighing 120 tons, made in any quality of steel, and also pieces in vanadium steel, manganese steel. The forging-shop for steel parts lately completed, is an up-to-date shop with steam hydraulic presses, steam and air hammers, belt-dropers, etc.

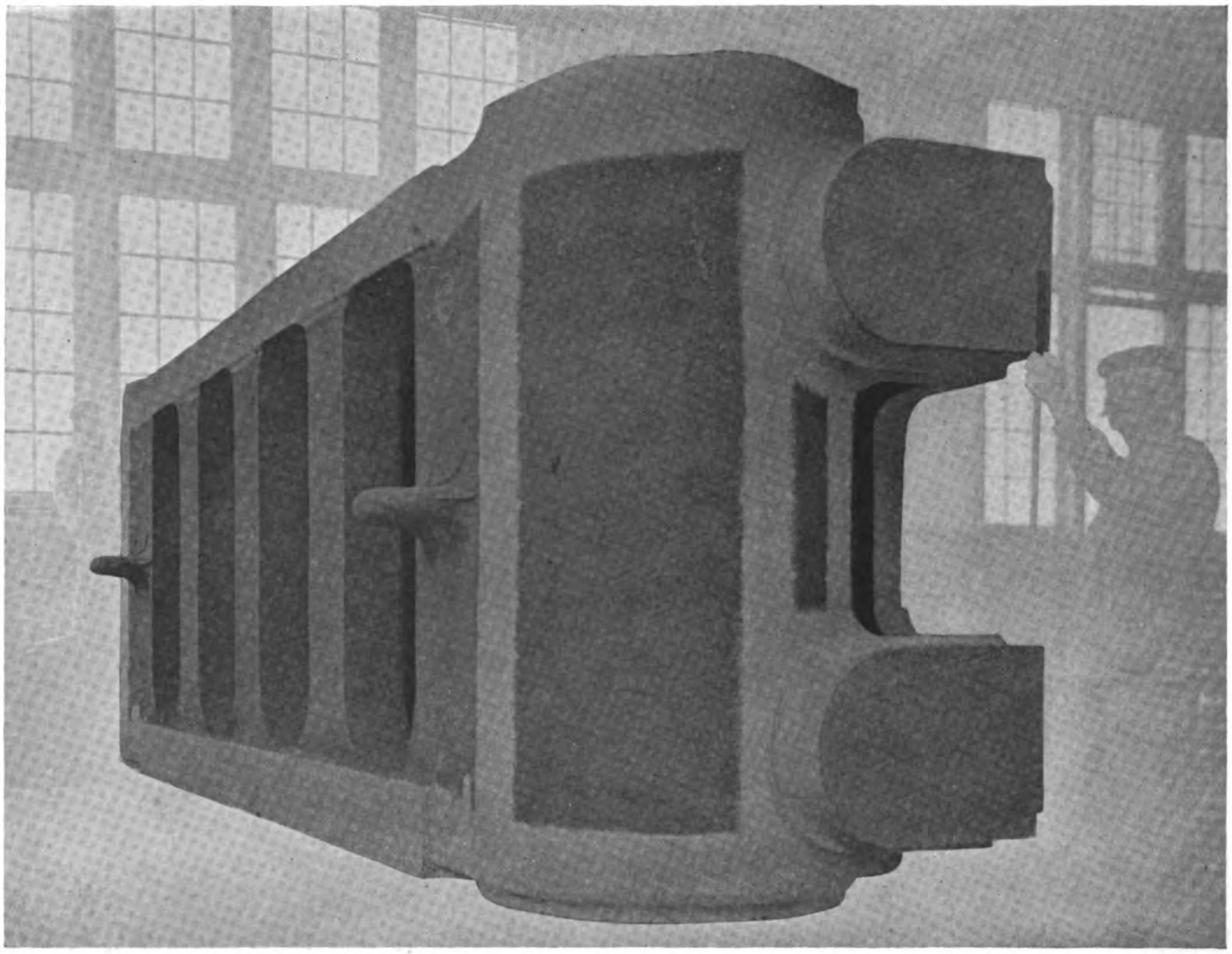


General View of Le Creusot Works



Steam-Turbine built by Le Creusot Plant

Steam-Hammers Shop at Le Creusot Plant



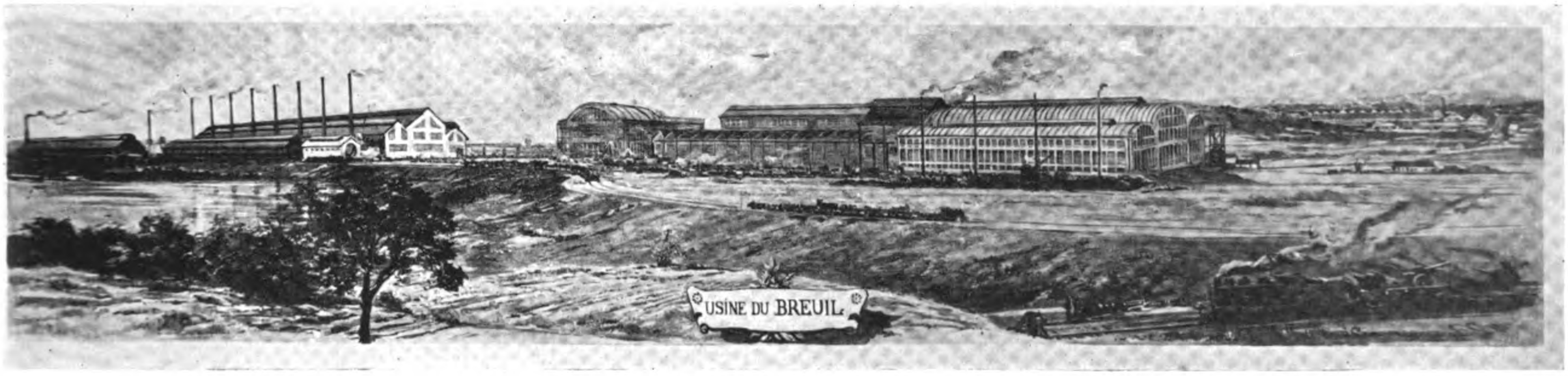
120-Ton Steel Casting Piece made at Le Creusot Plant

HENRI-PAUL WORKS situated at Montchanin-les-Mines (department of Saône-et-Loire) and thus named in memory of the eldest son of Monsieur Eugene Schneider.

These Works include:

An iron and bronze foundry, erected quite recently and destined to undergo very important developments in the near future.

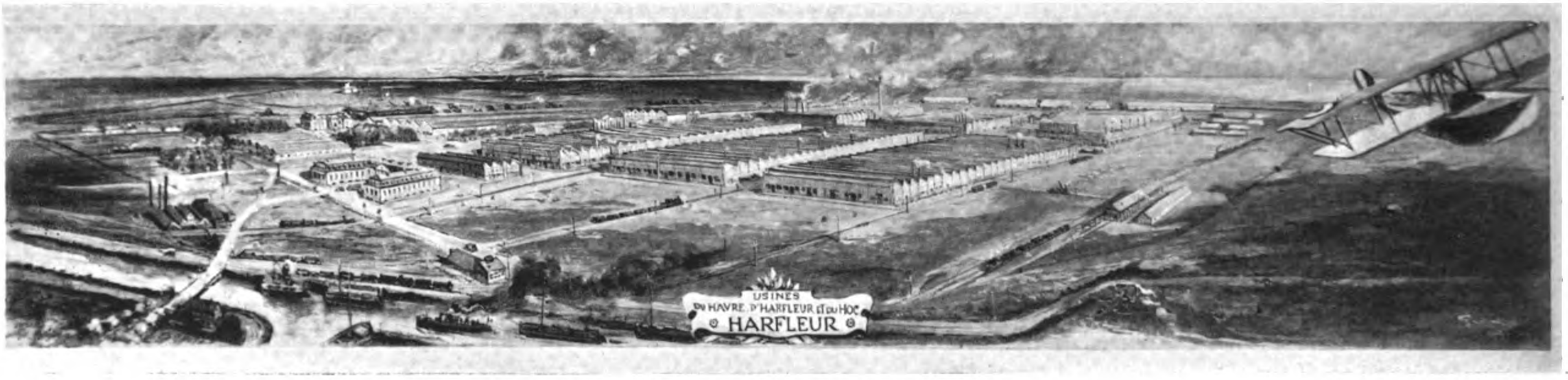
Coke-ovens with recovery of by-products.



General View of Le Breuil Works

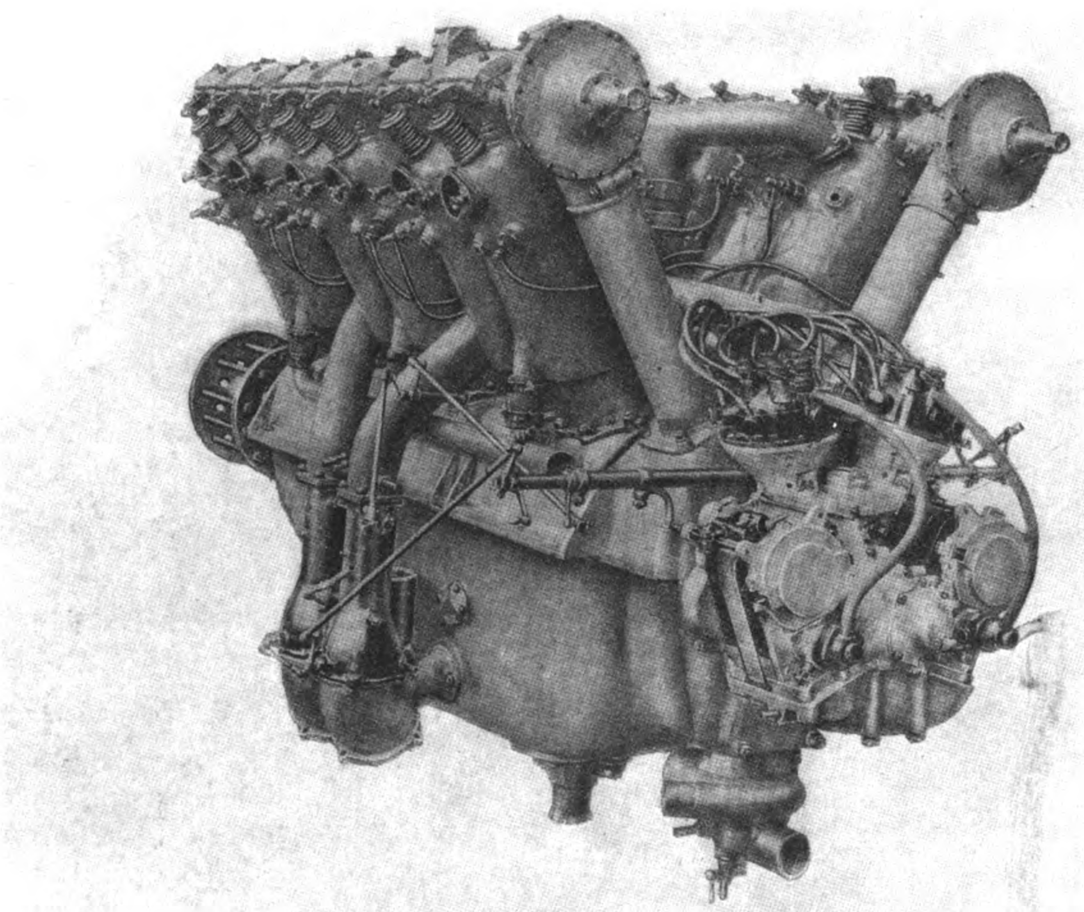
THE BREUIL WORKS near Le Creusot, representing the ideal of a modern powerful and highly-productive steel works, comprising all the very latest improvements; a battery of gas-producers with forced draught, automatically charged and cleaned; a scrap-metal yard provided with electromagnetic travelling-cranes; charging-appliances, charge-bridges for 60-ton open-hearth furnaces, casting-cranes, crushing-shops for dolomite and limestone, etc.

Casting House at Le Breuil Steel Works



General View of Havre Harfleur and Hoc Works

HAVRE, HARFLEUR AND HOC WORKS, comprising extensive engineering workshops for aviation engines, electromotors, marine and stationary Diesel engines; pyrotechnical shops; long-range proving-ground for gun-firing tests, etc.



Aviation Motor of 400 H.P. 12 Cylinders, built at Havre Plant

General View of Chalon Works

CHALON WORKS, which are especially equipped for the building of metal bridges, iron frameworks, public works, and small naval craft (submarines, torpedoes, destroyers, etc).

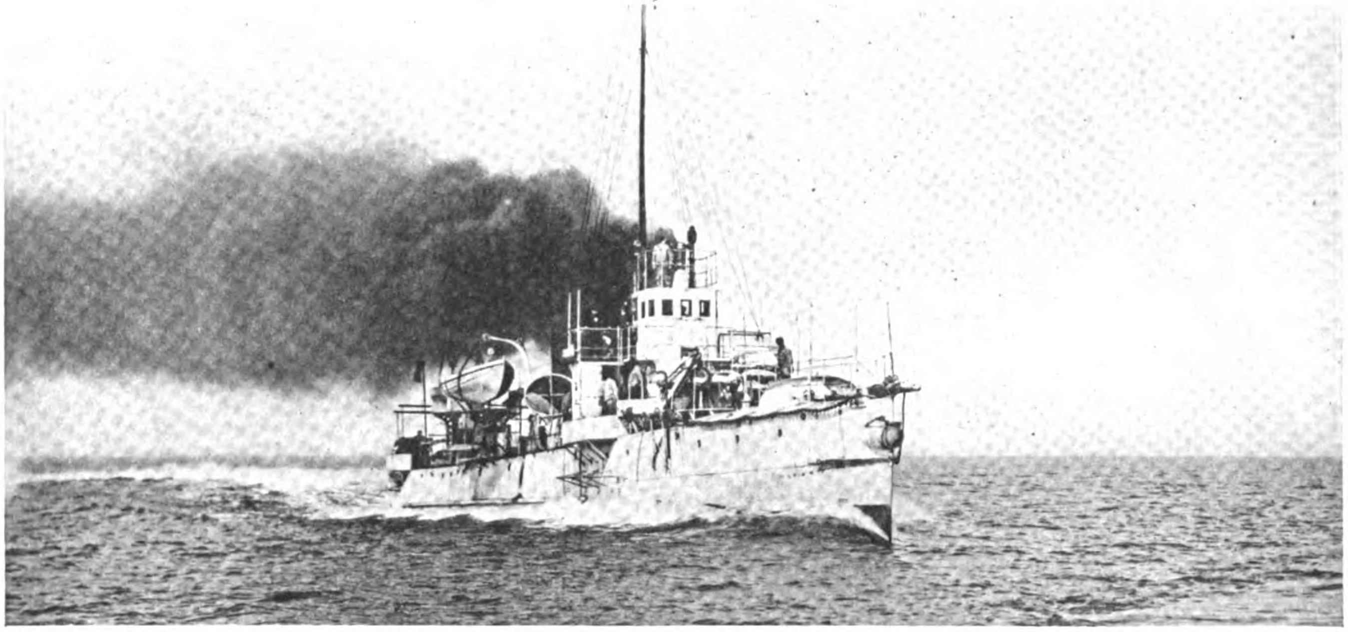
Chalon Works have built numerous bridges for France and for foreign countries; in particular the main part of the Alexander III Bridge in Paris was constructed in these works.

This branch of Messrs. Schneider's Establishments also has dredged and equipped many harbors.

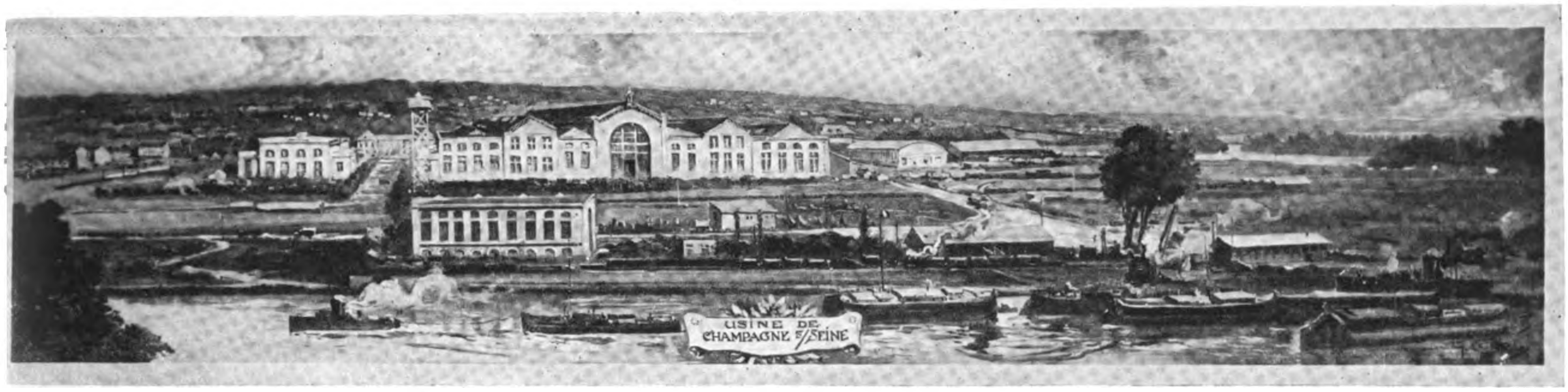
Alexander III Bridge at Paris

Rio Malleco Bridge, Chili, built by Chalon Works

Powerful up-to-date plants at the Chalon Works, enable all work to be carried out in connection with the making of large boilers, forgings, stampings and galvanizing.



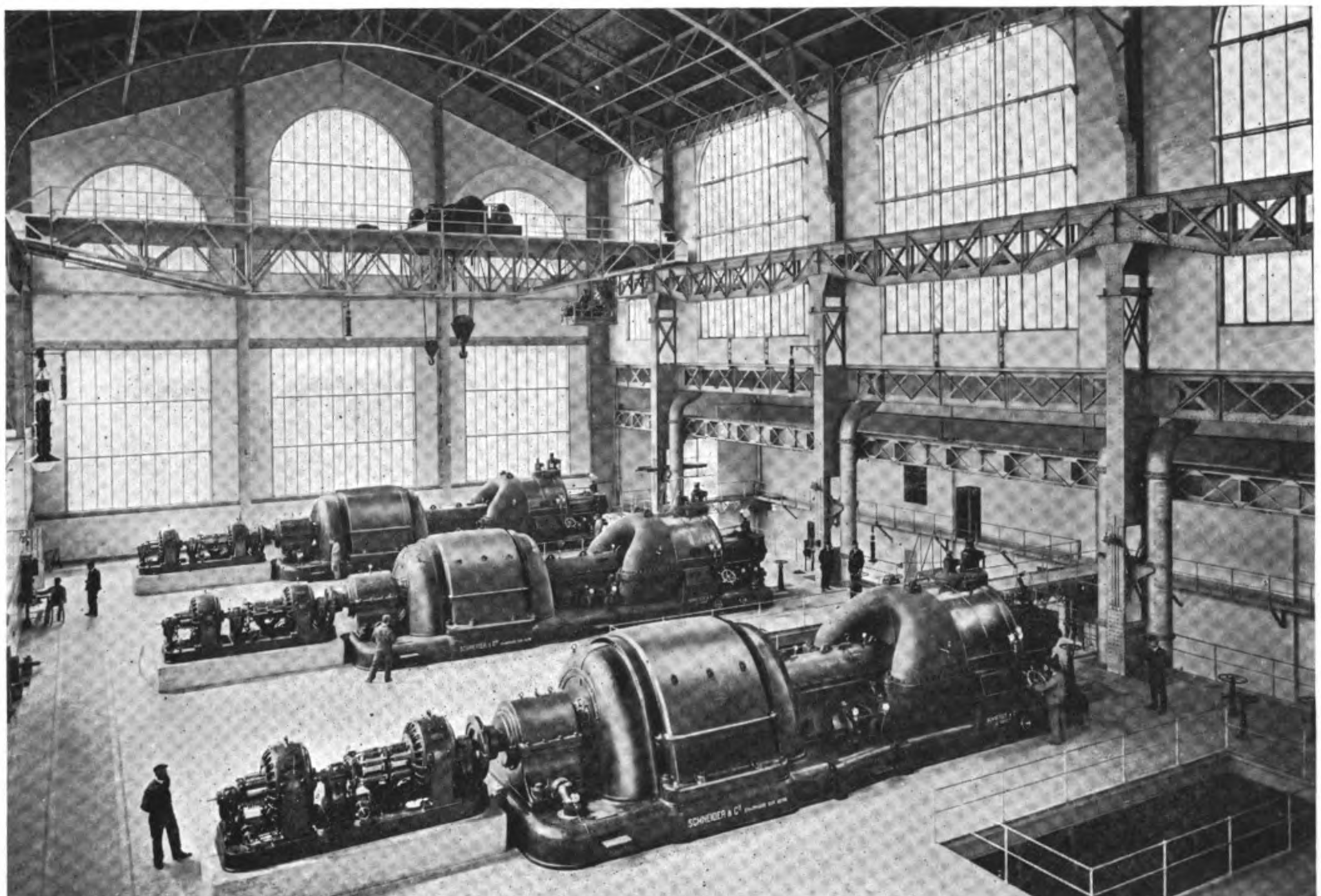
One of the many Destroyers built by Chalon Works



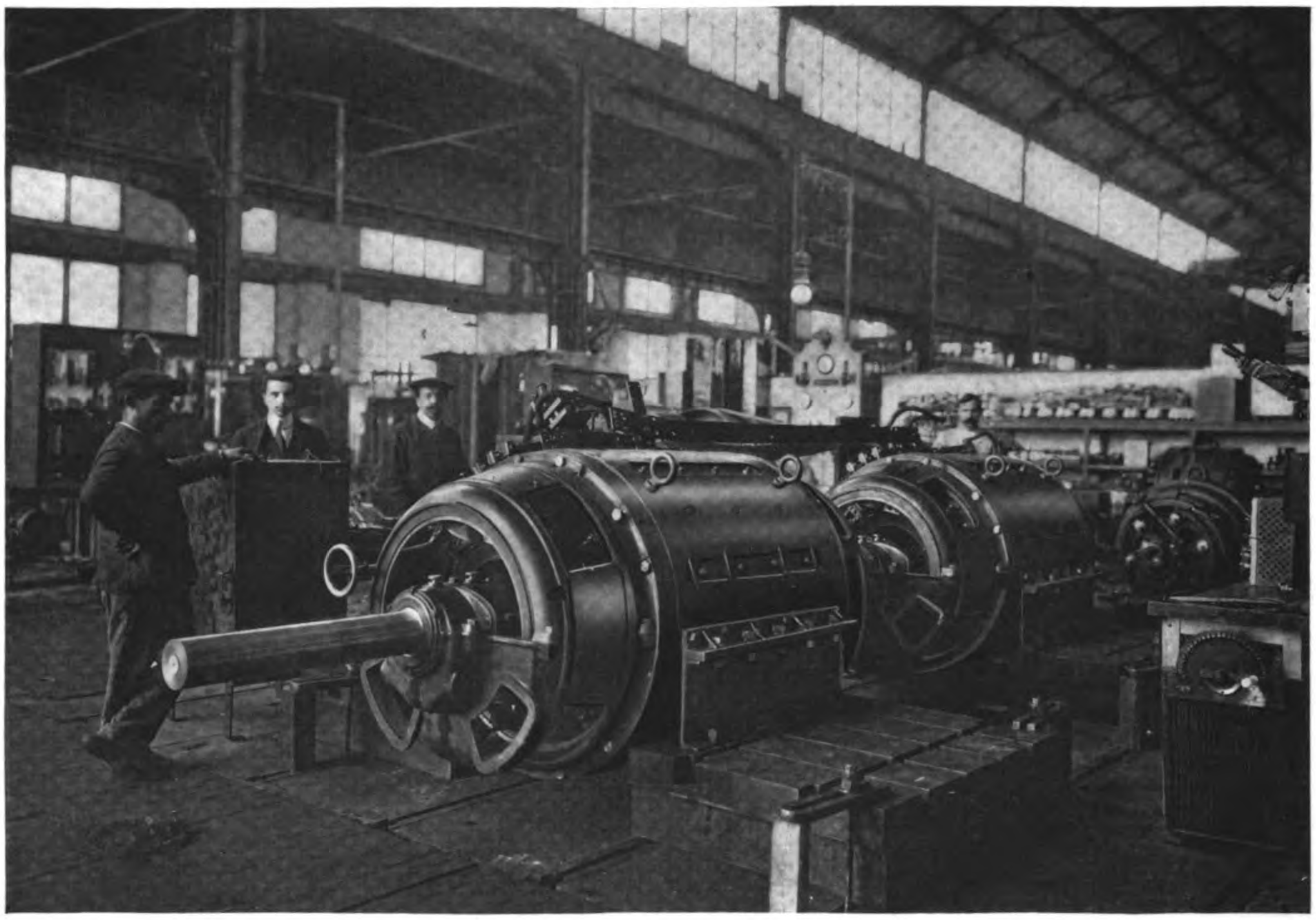
General View of Champagne-sur-Seine Works

CHAMPAGNE-SUR-SEINE WORKS, especially erected for the manufacture of electric machinery of any capacity, such as turbo-alternators, transformers, rotary-converters etc.; electric equipment for traveling cranes, winches, rolling-mills etc.; motors for electric tractors and self-propelled cars; motors and other electric equipment for submarines, etc.

LA LONDE-LES-MAURES WORKS (VAR), equipped for the construction of torpedoes, small electromotors, etc.



Engine Room of the Compagnie Parisienne de Distribution d'Electricité, Issy-les-Molineaux. (Seine)
Turbo-alternators 10,000 Kws, 12,000 V, 1260 RPM, built by Messrs. Schneider et Cie



Electromotors for submarines, built by the Champagne-sur-Seine Works

PRECISION SHOPS, PARIS, organized for the manufacture of sighting devices, goniometers, etc.

BORDEAUX WORKS for making cartridges and light alloys, etc.

CHAILLAC IRON MINES (Indre).

DECIZE COLLIERIES (Nievre).

DROITAUMONT IRON MINES (Meurthe-et-Moselle).

STATISTICS OF THE SCHNEIDER ESTABLISHMENTS
(Not Including Subsidiary Plants)

THE following figures, which are obtained from recent statistics, will give an idea of the importance of the SCHNEIDER WORKS:—

Total area of grounds owned: about 17,300 acres.

The engines, supplying power to the various shops, develop a total power of about 200,000 H. P.

Machines-tools now being used: about 5,000.

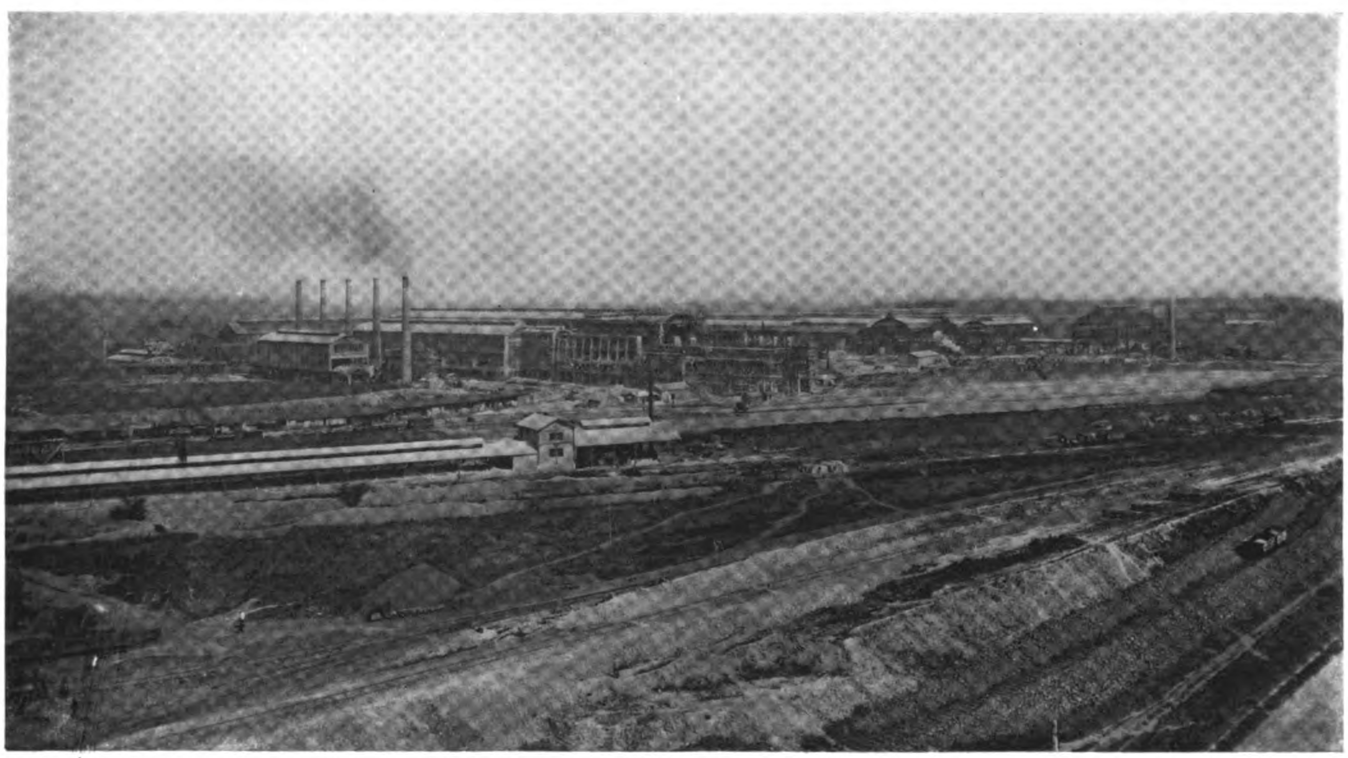
80 locomotives and 6,500 trucks are provided for the traffic in the works and run on standard-gauge tracks, the total length of which represents over 200 miles.

In addition, over 2,500 telephone-stations are established in the different offices and shops.

THE SUBSIDIARIES OF MESSRS. SCHNEIDER & C[IE]

In order to ensure the rapid growth of his Works, Monsieur Eugène SCHNEIDER has thought fit to establish a number of subsidiaries both in France and abroad; the most important of these are:

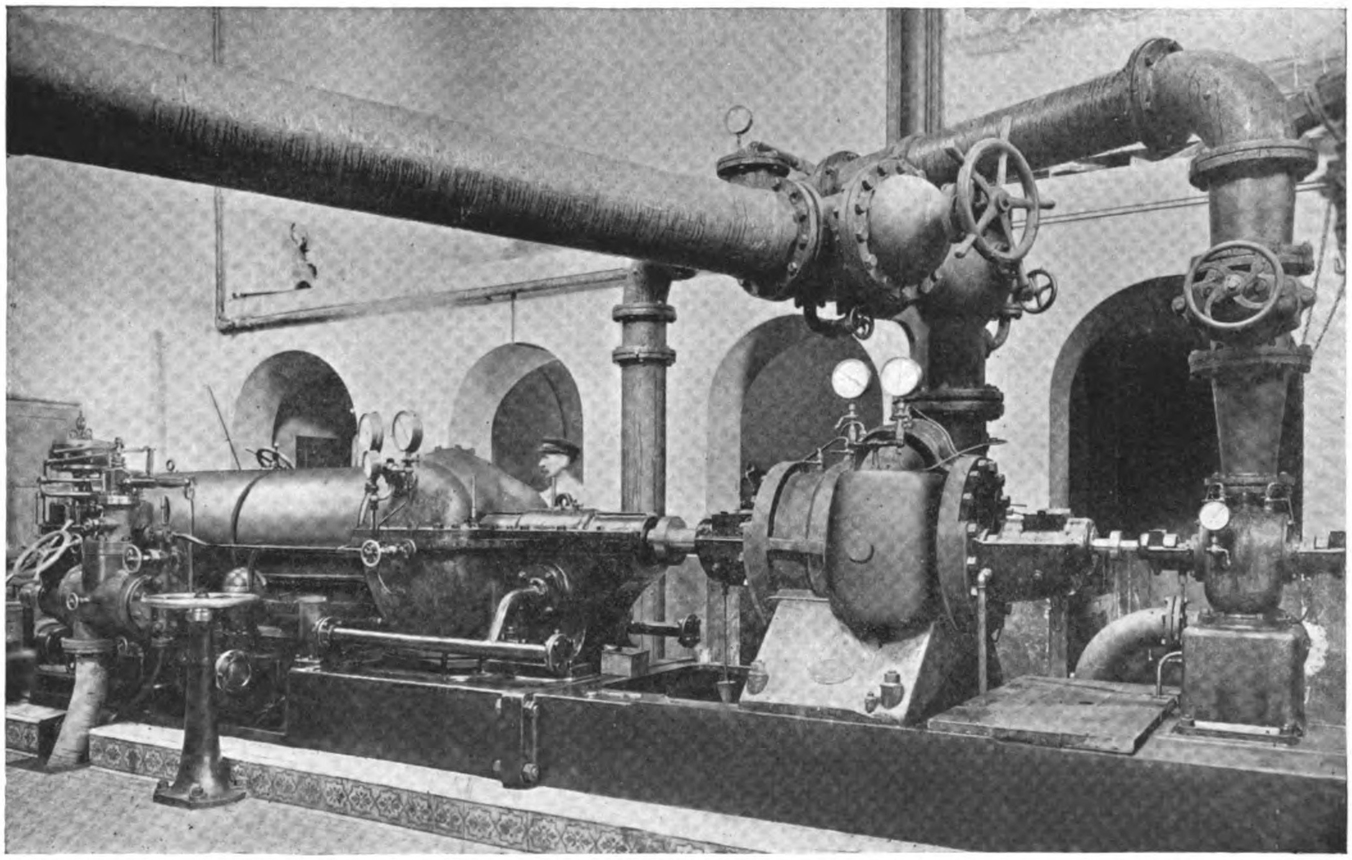
LA SOCIETE NORMANDE DE METALLURGIE at Mondeville, near Caen (Calvados), whose works include blast-furnaces, open-hearth furnaces, coke-ovens, rolling-mills, etc.



General View of Steel Works and Rolling Mills at Caen Plant

LA SOCIETE D'OUTILLAGE MECANIQUE ET D'USINAGE D'ARTILLERIE at St. Ouen near Paris (shops at Montzeron and Venissieux), for the manufacture of machine-tools of every description, for the finishing of pieces of Ordnance, gear-cutting, etc., the building of motor-lorries, towing tractors for canals and other inland waters, farm tractors, etc.

Farm Tractor built by the Société d'Outillage Mécanique et Usinage d'Artillerie



Versailles Municipal Service. Rotary pump of 140,000 gallons hourly capacity elevating at 600 feet, built by the Société des Moteurs á gaz et d'Industrie Mećanique

LA SOCIETE DES MOTEURS A GAS ET D'INDUSTRIE MECANIQUE Paris, for the manufacture of appliances and machinery of every description and especially for gas, oil, spirit, and air engines, ice-making and refrigerating machinery, etc.

LA SOCIETE D'OPTIQUE ET DE MECANIQUE DE HAUTE PRECISION, Paris, for the manufacture and sale of optical instruments and highly accurate mechanical devices.

LA SOCIETE DES CHANTIERS ET ATELIERS DE LA GIRONDE for the building of dreadnoughts, cruisers, cargo-boats, and other crafts of any tonnage.

LA SOCIETE PROVENÇALE DE CONSTRUCTIONS NAVALES, at Marseilles for building all kinds of ships, etc.

LA SOCIETE NORMANDE DE CONSTRUCTIONS NAVALES, at Havre and Cherbourg, for building all kinds of merchant-ships, iron frame-works etc., and for work connected with boilers, engineering, etc.

LA SOCIETE DES CHARBONNAGES DE WINTERSLAG, IN THE BELGIAN CAMPINE.

LES MINES DE FER DE LA PINOUSE.

VARIOUS COMPANIES in Russia, the activity of which has unfortunately decreased in consequence of recent events, but which formerly provided employment for over 50,000 workmen.

BESIDES these subsidiaries, Messrs. Schneider & Cie have a considerable interest, and are large shareholders, in a great number of French and Foreign companies which have not been included in the foregoing lists.

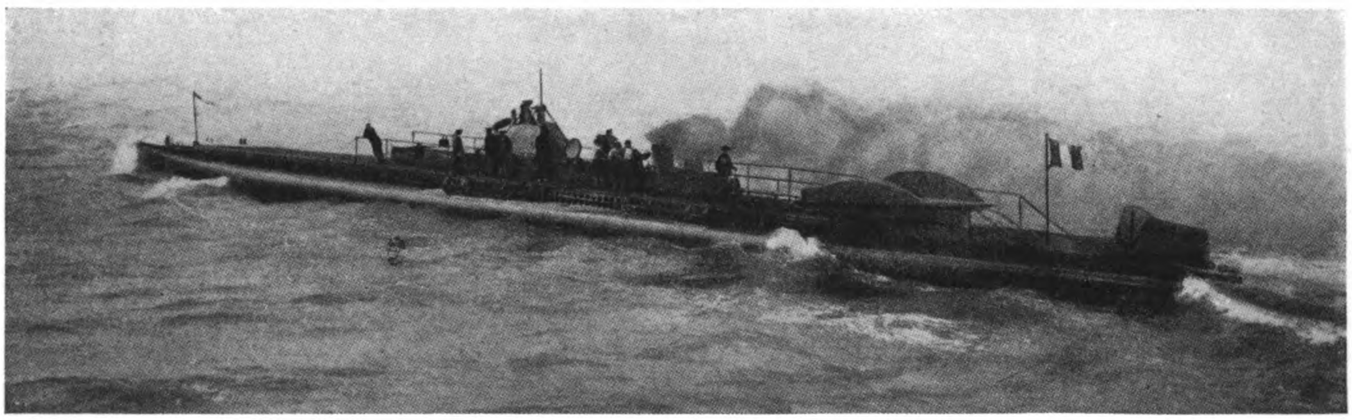
MOTORS FOR MARITIME PURPOSES

A Discussion of the Development of the Schneider (Diesel-type) Oil-Engine for Submarines, and Its Intimate Relation to Merchant-Ship Propulsion.

THE PROBLEM OF MACHINERY FOR SURFACE RUNNING

THE history of the use of the Diesel-type heavy-oil engine for merchant-marine purposes is intimately connected with that of submarine construction and navigation, and, at the time when the propelling of large mercantile vessels by means of the internal-combustion motor had not been seriously considered, the propelling of submarines on the surface already had presented the question of its development and adoption, because it represented power machinery which would meet the following conditions:

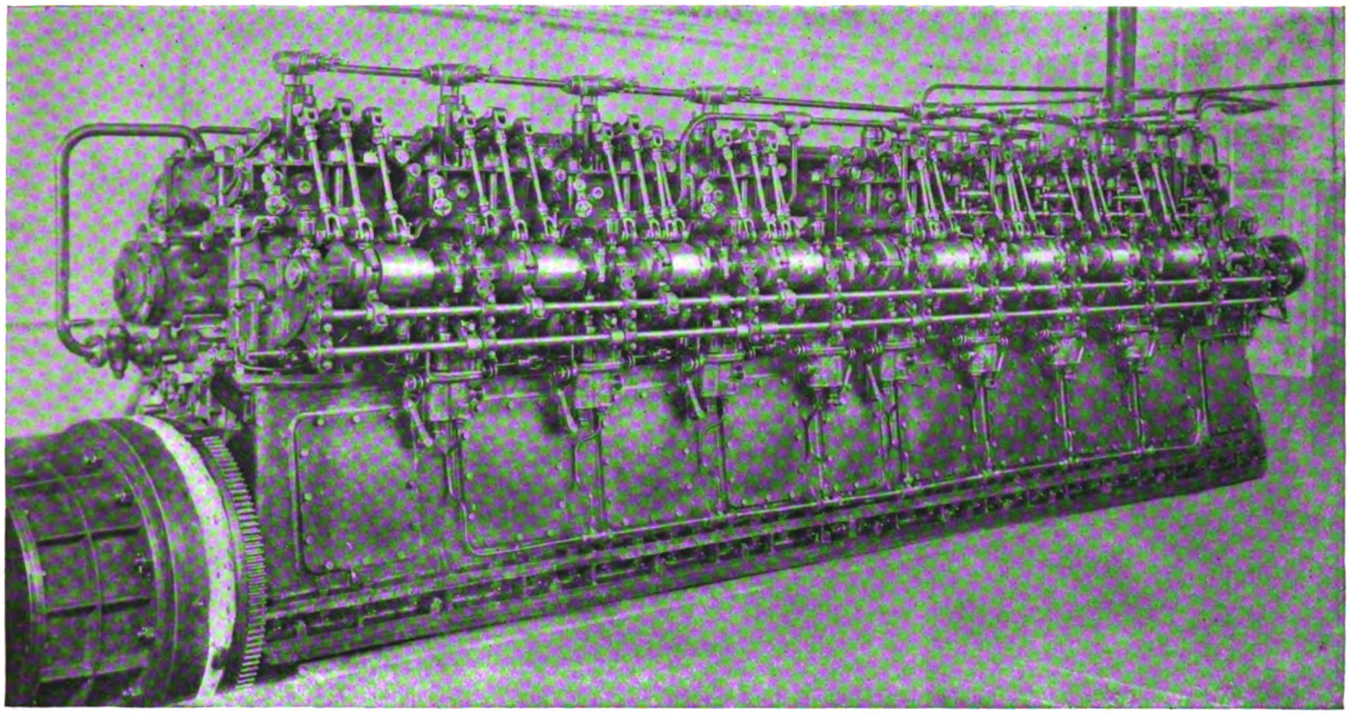
1. Great possibilities for reducing crowding; space always being so exceedingly limited on ships, especially with submarines.
2. Possibility of an instantaneous stop when running on the surface where it is vulnerable, allowing the submarine to seek safety by submerging quickly.
3. Rapid starting of surface-engines, enabling the emerging submarine to quickly use this machinery, which usually is more powerful and always more economical than the electric-motor with storage battery used while running submerged.
4. Maximum reduction of the heat generated by the engine in the interior of the vessel, where it is difficult at all times—and impossible while submerged—to renew the atmosphere.
5. The use of a combustible-fuel easy to store—always a good reason where there is little available space, and as fast as it is consumed it can readily be balanced by bringing into the vessel its equivalent weight in sea-water—thus maintaining the equilibrium of the submarine.
6. Safety in use, so far as it concerns the machinery of the submarine itself and the fuel.



The "Papin" a steam-driven submarine built by Messrs. Schneider & Cie

At the time when the subject came up in this connection, which was during the last years of the 19th century, the question of submarine navigation could have really been said to be established. The French crafts "Gymnote" and "Gustave Zede," and the first submarines of the firm of Holland, had brought to an issue the great number of problems which arose in regard to a totally submerged vessel. But these early vessels were propelled by electric-motors fed from storage batteries. Their radius of action was consequently very limited.

The idea of the dual machinery—one set for running on the surface—the other for use in submerged navigation, was already old—Alstitt conceived it first, we believe in 1863. But, the simple scheme, described above, of conditions met by a



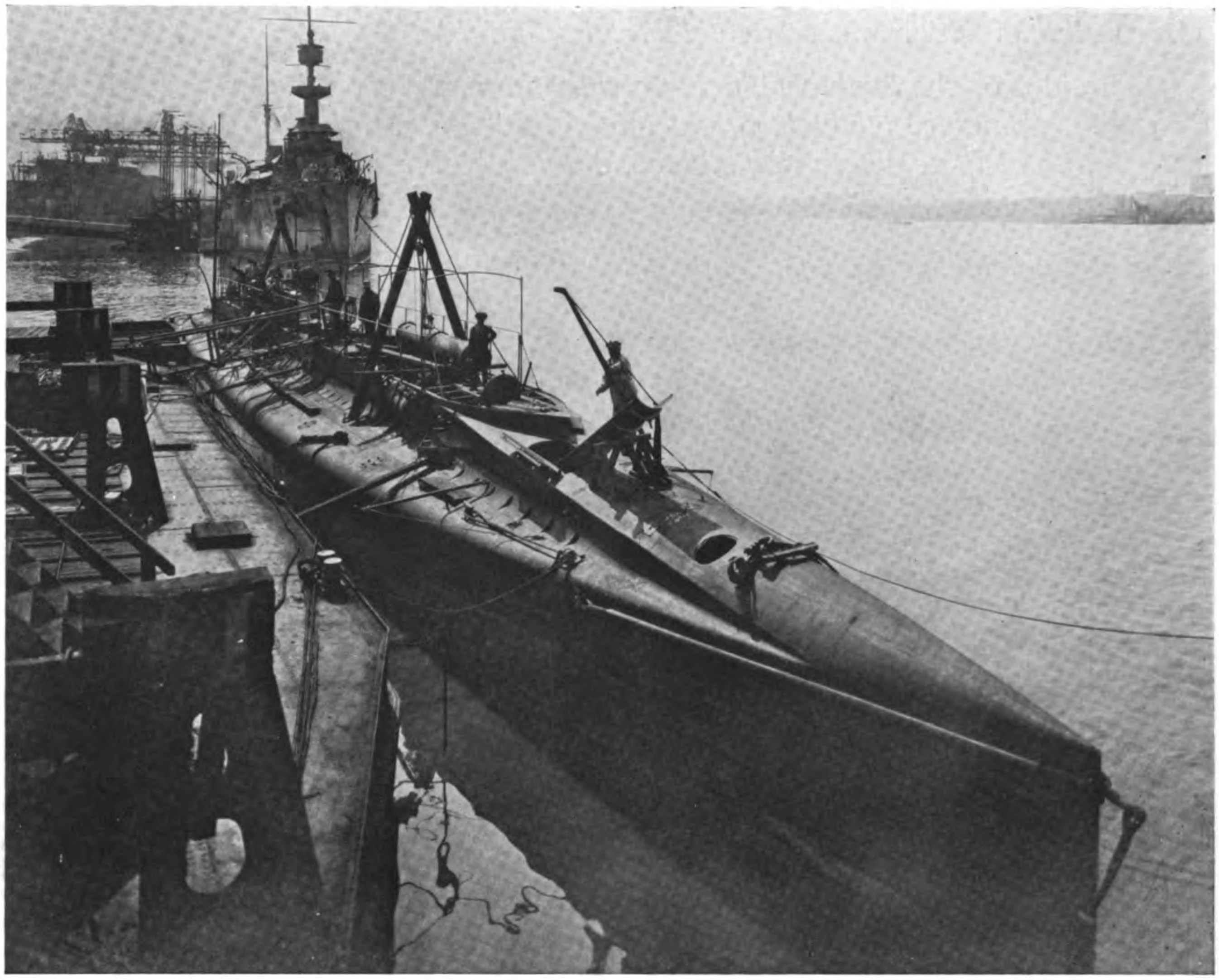
A Schneider four-cycle type submarine Diesel engine of 360 b.h.p.

separate surface engine showed difficulties in the way of achieving a really satisfactory apparatus.

A solution was found in 1897, almost about the same time by engineer Holland in America and by engineer Laubeuf in France. The "Plunger," of the first-named design, was fitted with a gasoline motor coupled to an electric-motor for submerging and for using when coming-up to the surface. The "Narval" of Mr. Laubeuf was propelled by a steam-engine fed from a kerosene-fired boiler, and also connected to an electric-motor for submerged running.

But these solutions both showed serious short-comings. The gasoline motor at this time was very imperfect. The fuel, being very volatile, diffused itself in the atmosphere causing explosions and asphyxia. Many unfortunate accidents served to confirm the fears in regard to the use of gasoline.

Regarding the steam-engine of the "Narval," this remained in use until fifteen years later. But, the steam-engine only imperfectly met the requirements of the surface machinery of the submarine, especially as the sudden shutting-down of the boiler at the time of submerging was not without a certain danger of exhaling of



The Diesel-driven submarine "Antigone," S.D.4. built and engined by Messrs. Schneider & Cie

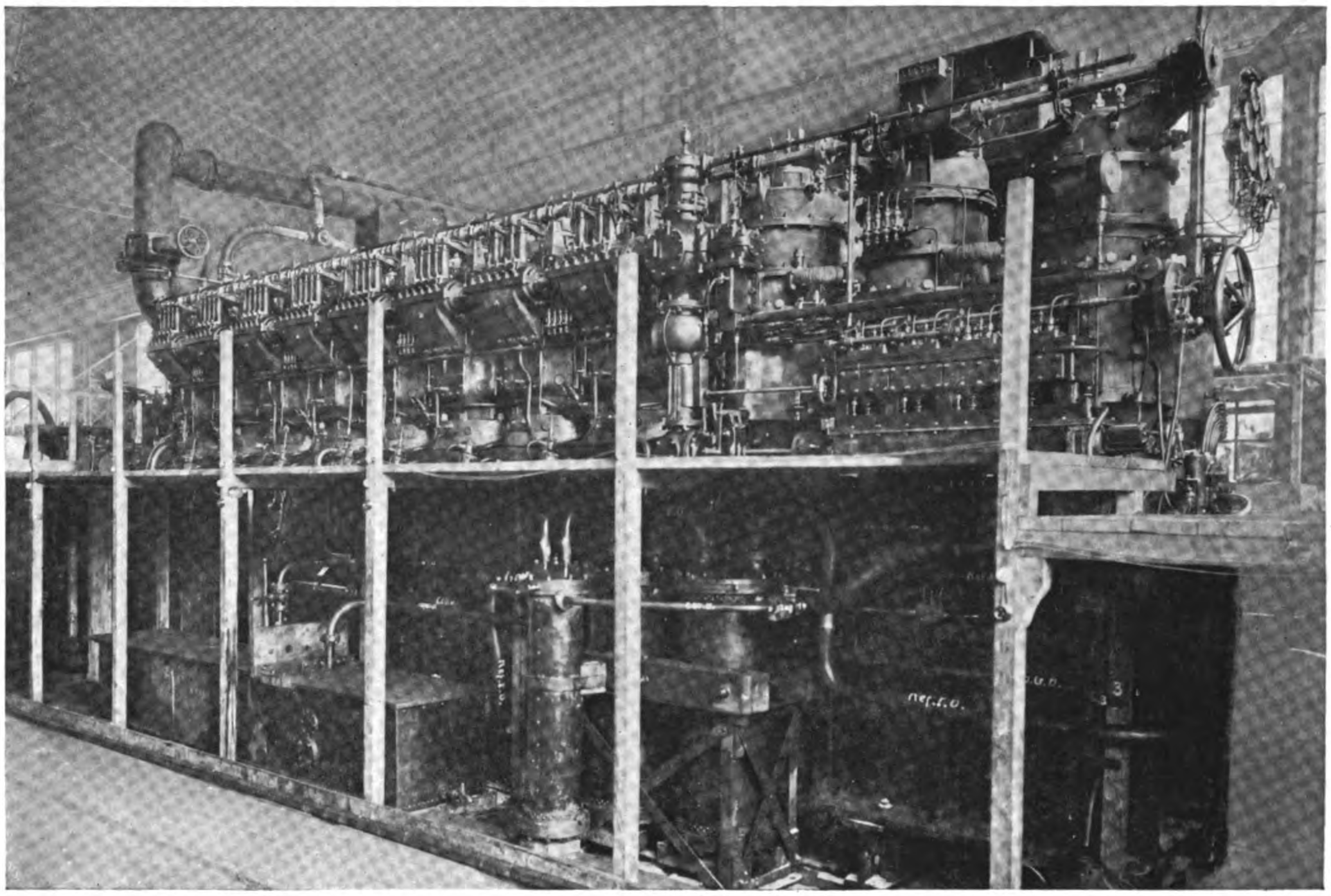
gas in the interior of the vessel, and was not without the creation of a great deal of heat during the first moments of submerging.

Nevertheless, the need of a better motive power stimulated the efforts of French designers during the last years of the 19th and the first years of the 20th century, and the results obtained helped to lessen the difficulties presented by steam power.

BUT when the heavy-oil engine appeared in practical form, it became clear that in the Diesel motor was the solution of propelling submarines on the surface, if it was possible to construct such an engine for the special requirements of the submarine.

However, American shipbuilders and English shipbuilders—who then began to take an interest in submarines—for several years continued to use gasoline engines. The French, and also the German shipbuilders who started to build submarines, vigorously pushed the adoption of the Diesel-type engine in their respective countries.

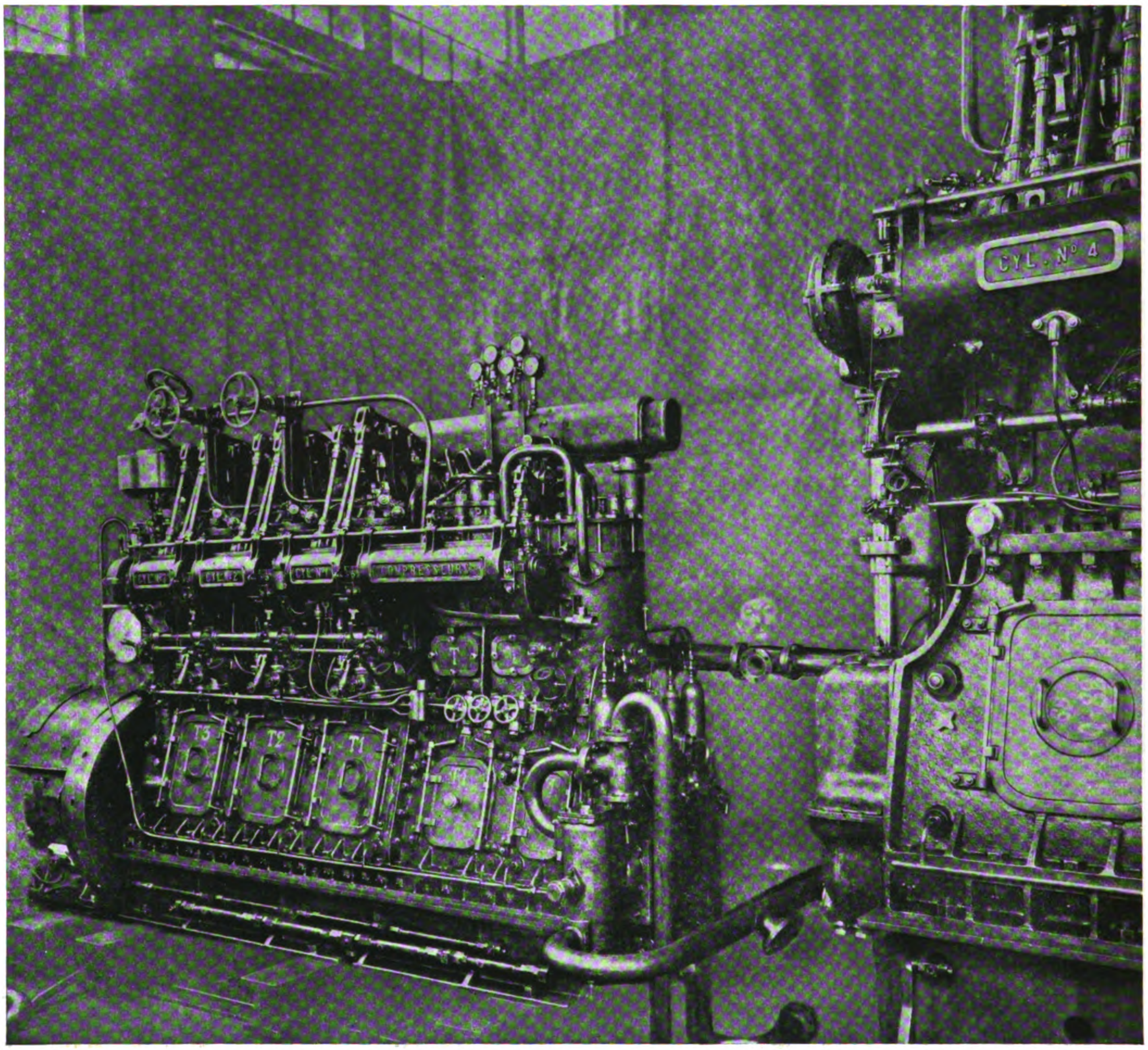
The first endeavors were arduous, for they were faced with the problem of developing from stationary-type engines weighing 900 to 1100 lbs. per horsepower at 40 to 50 revolutions-a-minute, such as had been produced by Dr. Rudolf Diesel and his early co-workers. Engines compactly constructed and of light weight, namely, 44 to 66 lbs. per horsepower at 350 to 400 revolutions per minute, alone were consistent with the space and the weight available on a submarine. The principles of both types of machinery naturally were the same. But, the reduc-



Starboard side of one of the 1450 b.h.p. Diesel-type Schneider engines of the French submarine "Fulton"

tion of the scantlings necessitated by the limited weight raised delicate questions in regard to the nature and the treatment of materials. Higher engine-speed, on the other hand, led to solving the difficult questions of balancing.

Contrary to what took place in the history of the steam-turbine—where the use of the turbine on board vessels has been modified by reducing the propeller-shaft speed in such a way that vessels are enabled to adopt exactly the same type

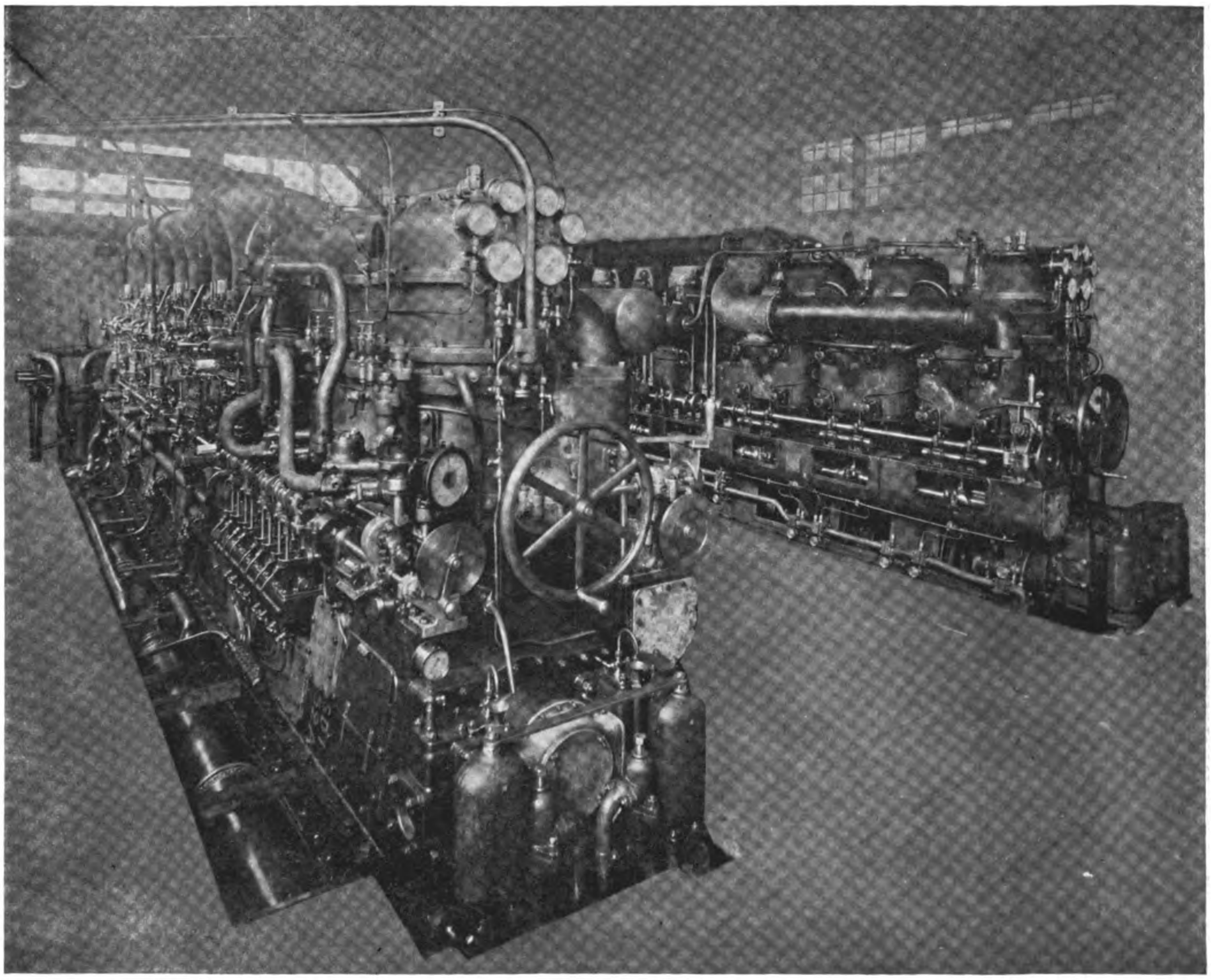


Auxiliary Diesel motor for the engine-room of the French submarine "Admiral Bourgois." The man indicates the size of one of the big propelling Diesel engines shown on the right.

of turbine as used on land—the stationary type Diesel motor had primarily to be changed to run at higher direct speed.

It also was the development of motors for submarines turning at 350 to 400 R.P.M. which brought about the stationary type motor of 200 to 250 R.P.M. operating with the same ease as the old heavy stationary motors of 40 to 50 R.P.M.

The Diesel engine thus owes to the submarine a certain measure of its success. On the other hand, it is no exaggeration to say that the modern submarine could not have existed without the internal-combustion engine as generally adopted for submarines for many years. The efforts afterwards made from time-to-time to re-introduce the steam engine on the submarine could not be taken but as the expression of a new need, for which the internal-combustion motor was for the time not adaptable. For instance, the creation of large submarines necessitated high-power which far surpassed that obtained from Diesel engines. This has

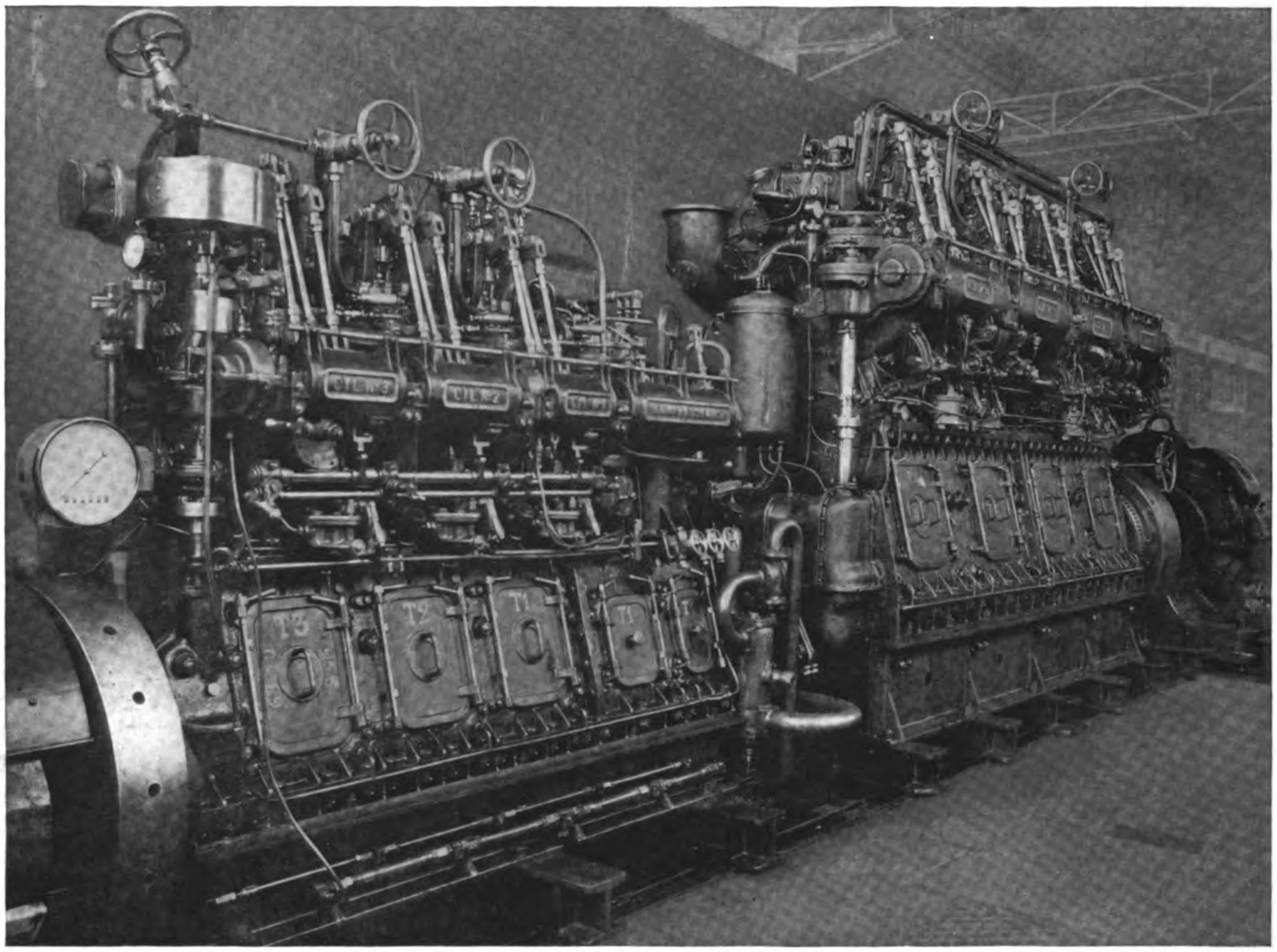


Two 1,100 b.h.p. Diesel-type Schneider engines built for the Japanese Navy. Weight with clutch, water and oil, 46 lbs. per b.h.p.

brought to the front the steam-turbine with reduction-gear. But the submersibles carrying this apparatus are but regarded as a compromise awaiting further development of the internal-combustion motor.

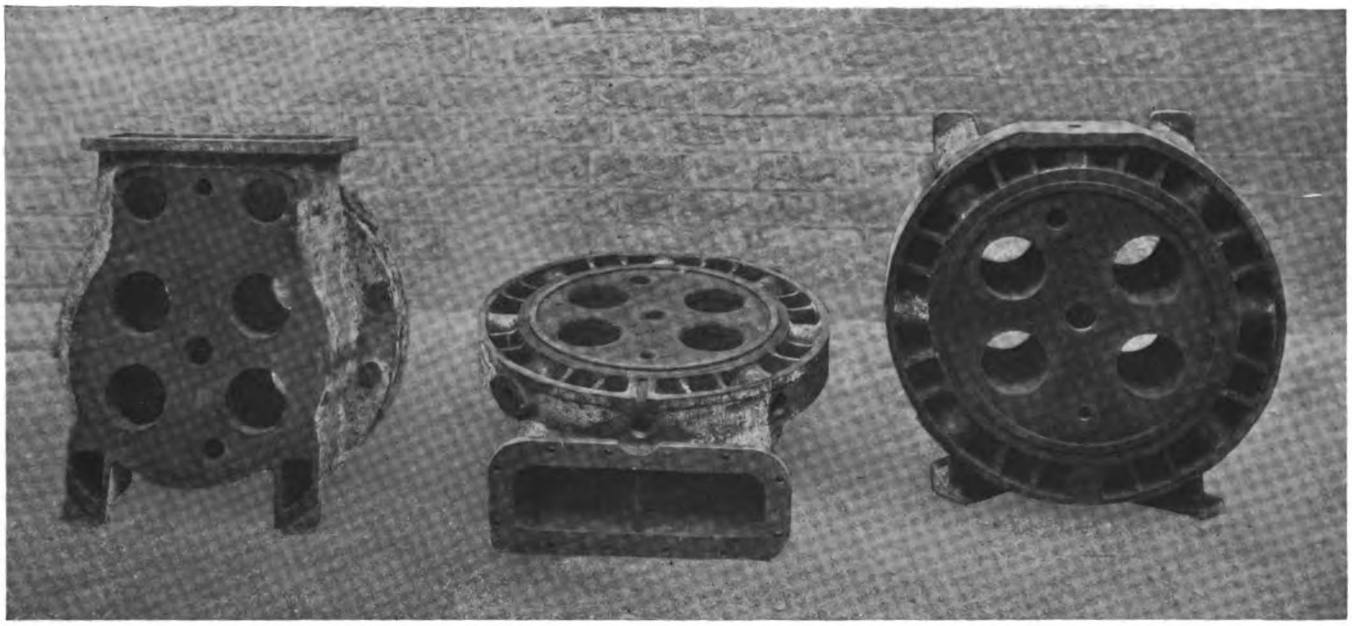
Now, until there is found a radically new method of propelling submarines, all submarines will be equipped with a surface-engine of the internal-combustion type, and an electric motor for submerged propulsion operated by a storage-battery.

This last apparatus has made little improvement for many years, and though heavy and clumsy, it does not seem likely that it can be perceptibly improved. But, such as it is, it provides great safety in use and makes good power for under-water cruising. It is clear that a new apparatus which would allow of double existing submerged speed would revolutionize this branch of naval construction. But it would require a radical change in the machinery used. This change seems but remotely possible.



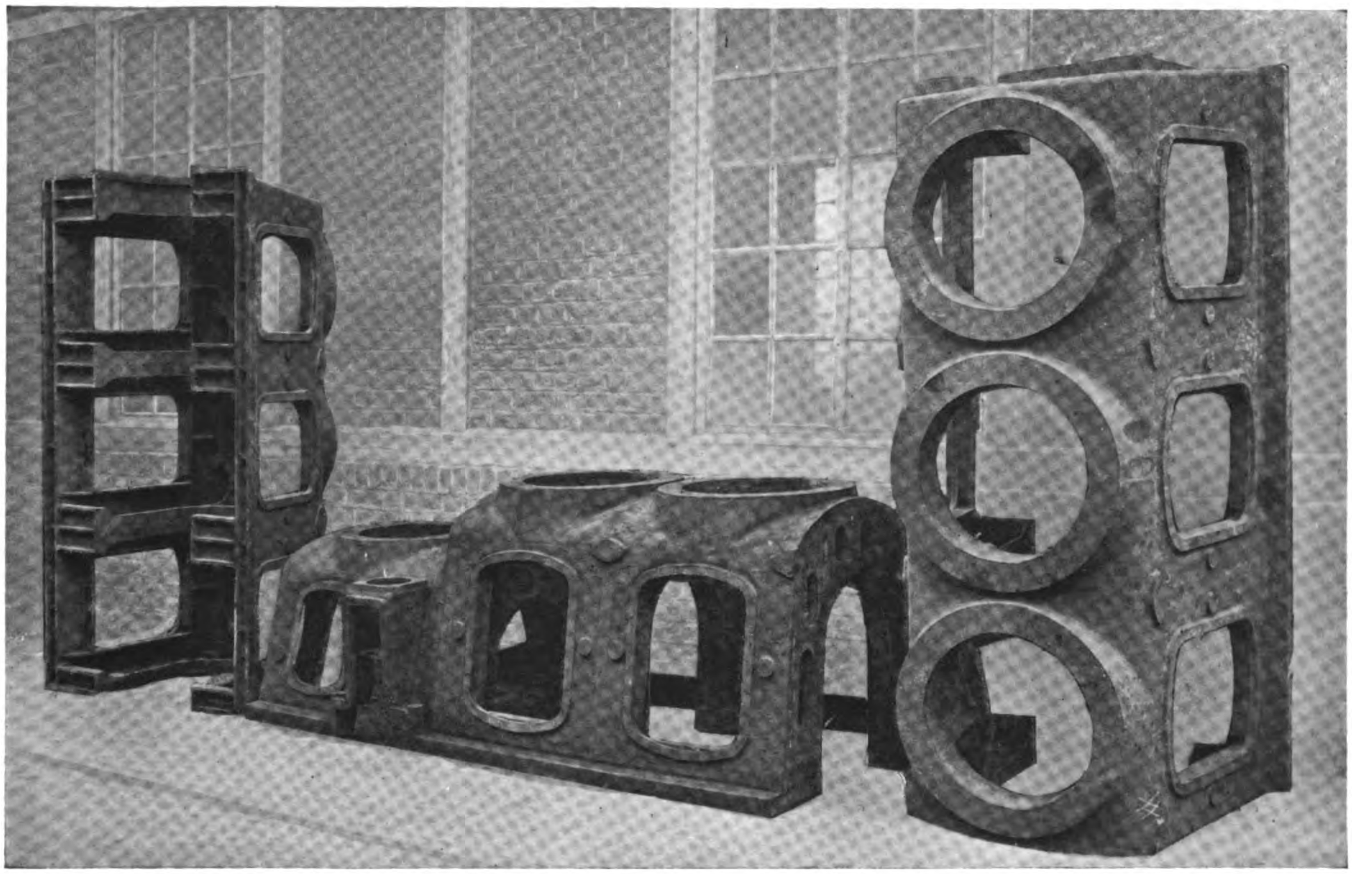
An auxiliary engine and a propelling Diesel engine of the submarine "Admiral Bourgois"

In the matter of machinery for surface operation, the heavy-oil combustion-motor is naturally able to meet all the requirements for a submarine with perfection. The power-weight ratio is considerable. The weight can be reduced to 44 lbs. to 55 lbs. per horse-power. The starting and stoppage are instantaneous. With a few trifling precautions—such as maintaining the flow of cooling water for a few moments after stopping—the heat generated by the engine, even after a long trip, remains moderate when submerged, so the atmosphere in the vessel is not uncomfortable. Finally the Diesel engine is adapted for burning heavy-oil having a flash-point high enough to obviate any danger of fire.

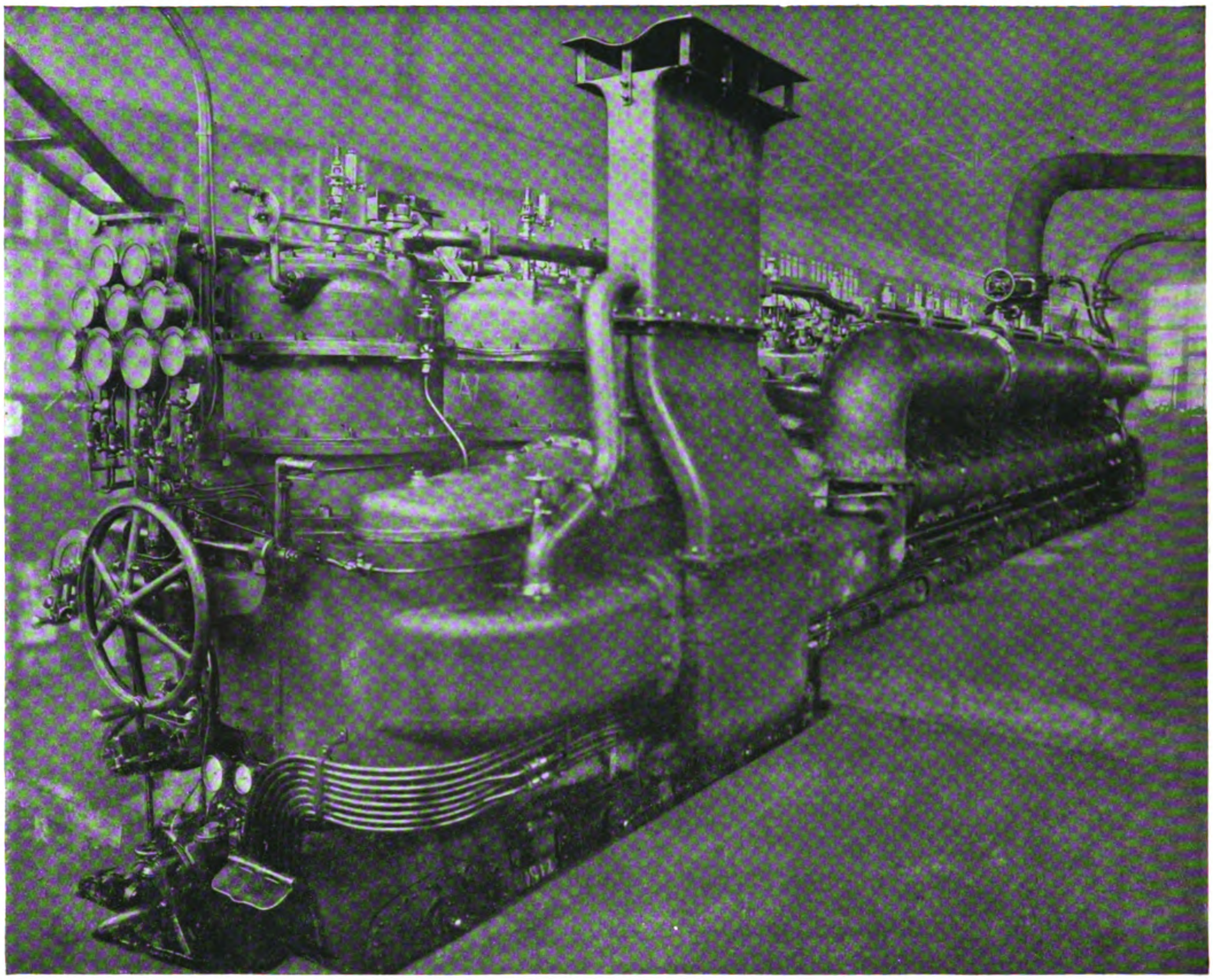


Examples of large steel cylinder-head castings for Schneider marine engines of the high-speed Diesel type

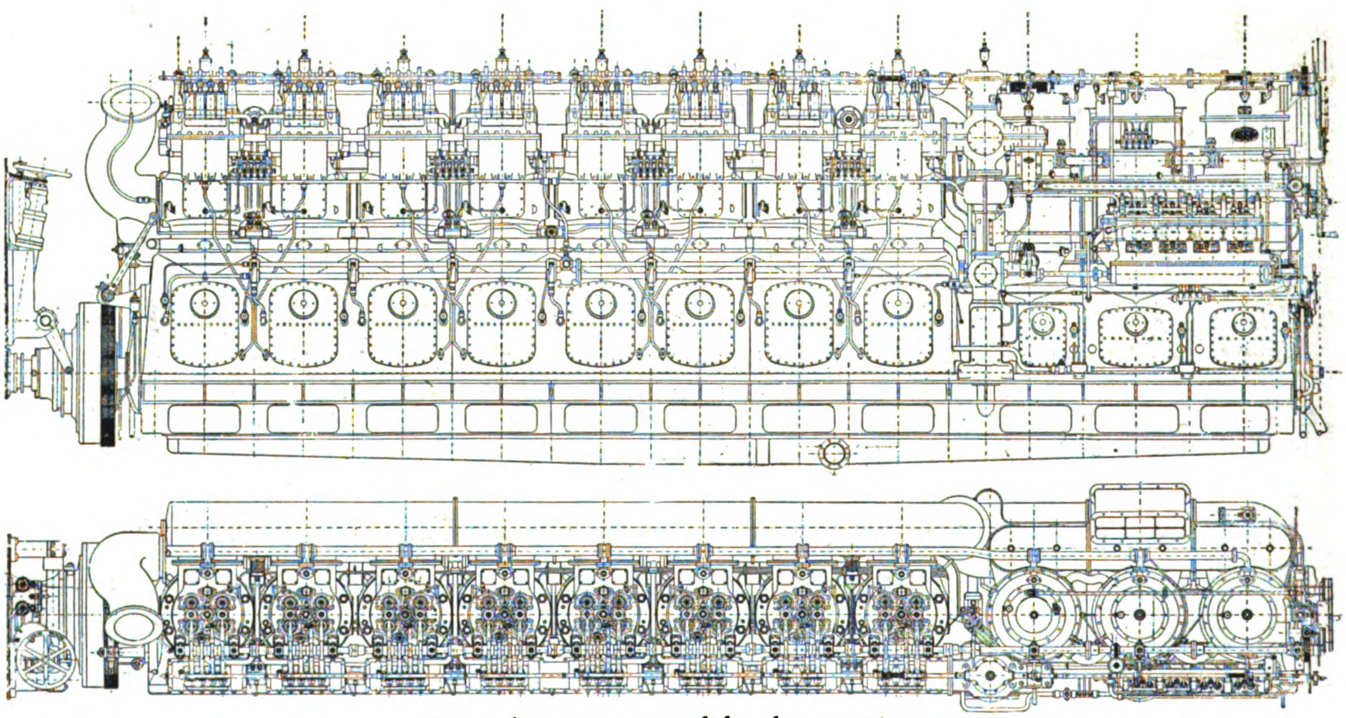
There still remains to be found an improvement whereby an already powerful oil-motor will give way to one of still higher power by overcoming very serious obstacles which arise, either from increasing the bore and the stroke of the cylinders or from augmenting the number of revolutions.



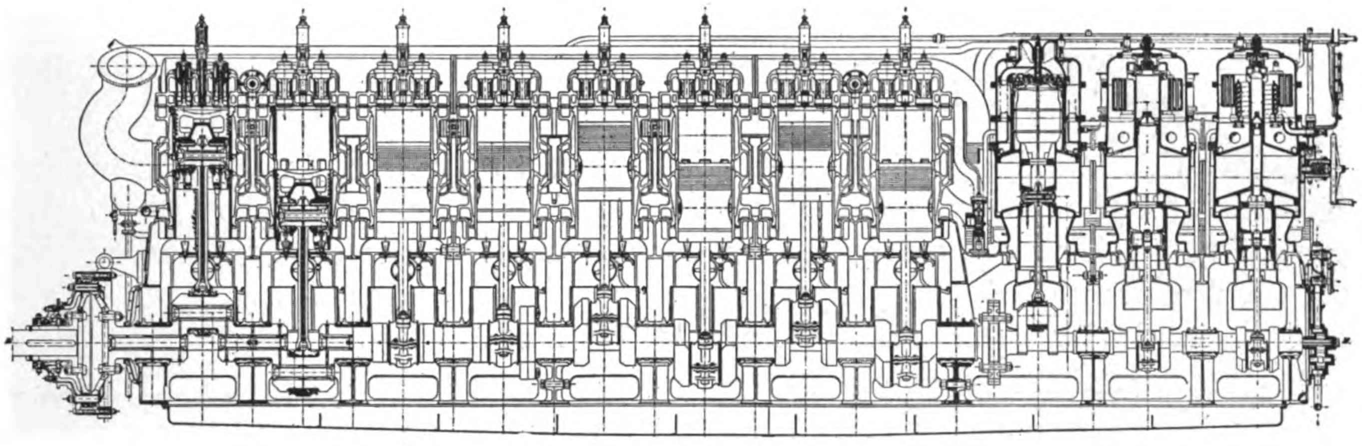
Crank-case castings for a large submarine-type Diesel engine made in one of Messrs. Schneider's foundries

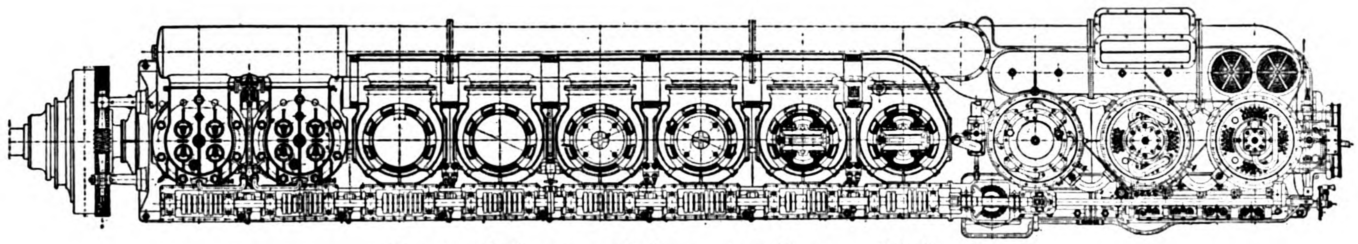


Two of these big Diesel-type Schneider engines are installed in the submarines "Fulton" and "Joessel." providing a total output of 2,900 b.h.p. (3,750 i.h.p. per boat)

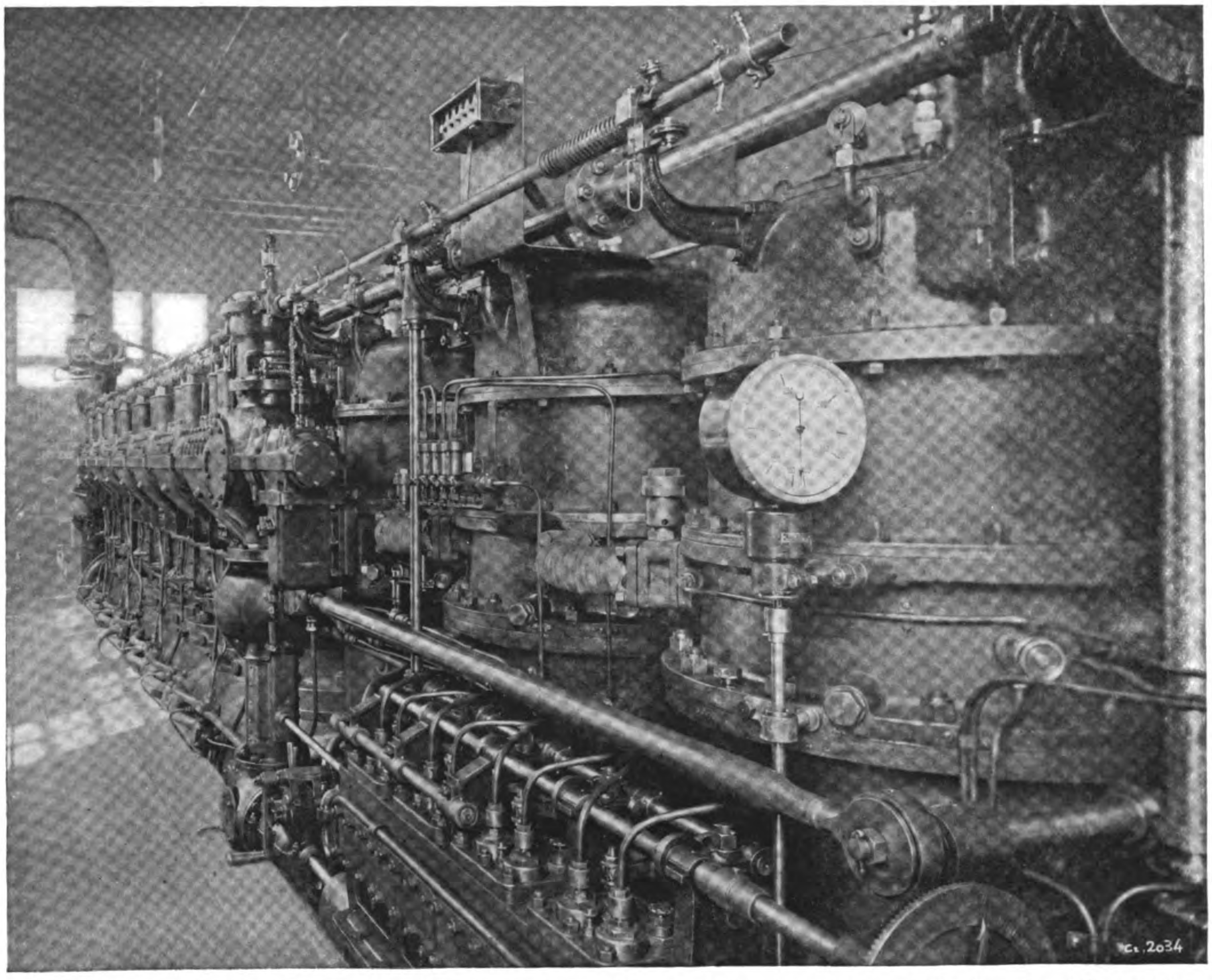


General arrangement of the above engine.





Sectional drawing of the engine illustrated below

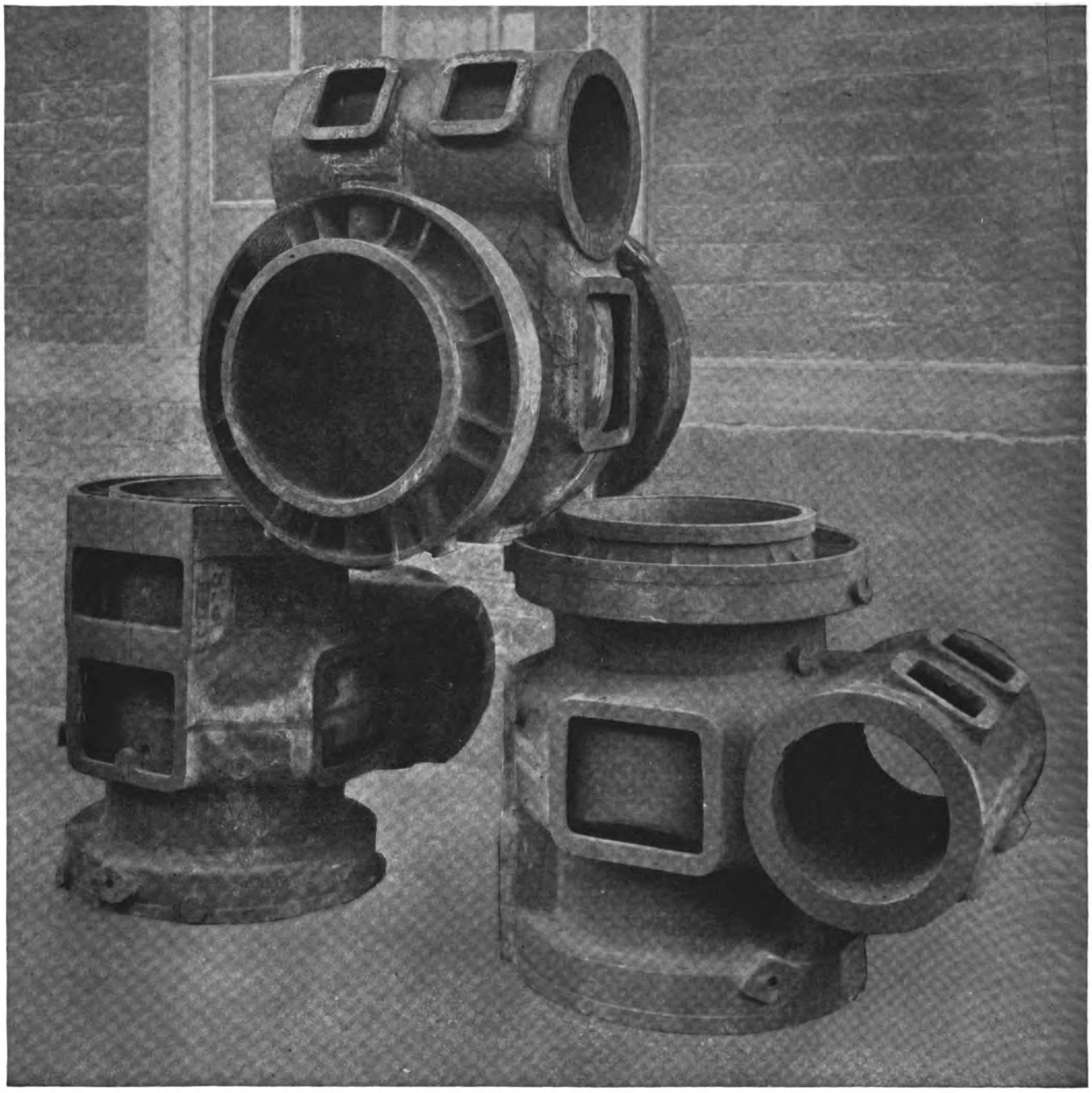


A 1450 b.h.p. Diesel-engine as built by Messrs. Schneider & Cie for the submarines "Fulton" and "Joessel" of the French Navy.

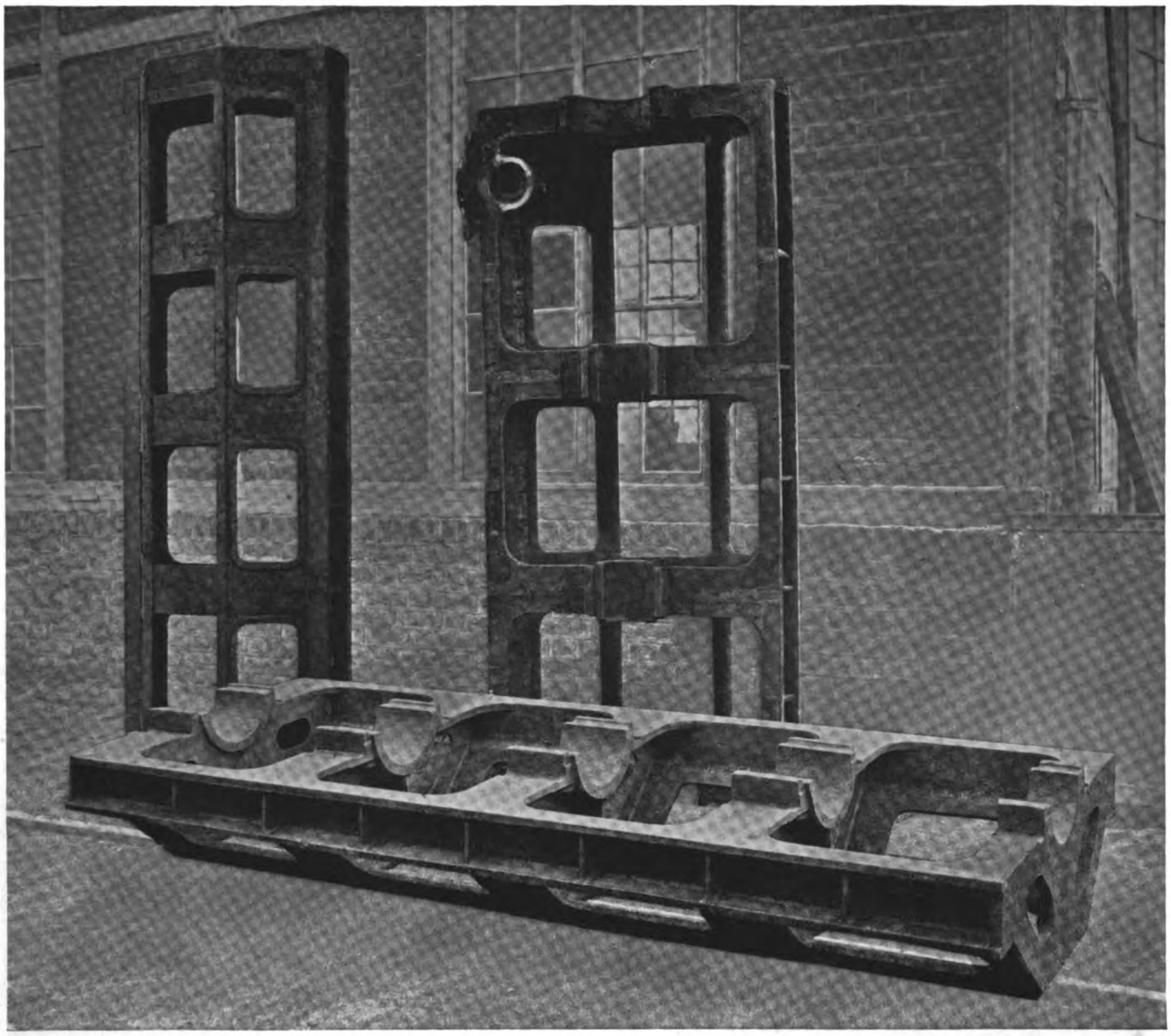
ADVANTAGE OF THE COMBINATION DESIGN IN RELATION TO THE SUBMARINE

FROM this standpoint, it is a simple matter to note that in a submarine the hull and the engine react upon each other. The space allotted to the propelling machinery is extremely small on account of the other intricate parts of a submarine; and the general value of the submarine is regulated in accordance with the best use of a more or less restricted space.

A manufacturer whose business puts him in a position which will enable him to study and to build at the same time both the hull and the engines of the sub-



Cylinder castings for high-powered Naval-type Diesel engine made by Messrs. Schneider & Cie



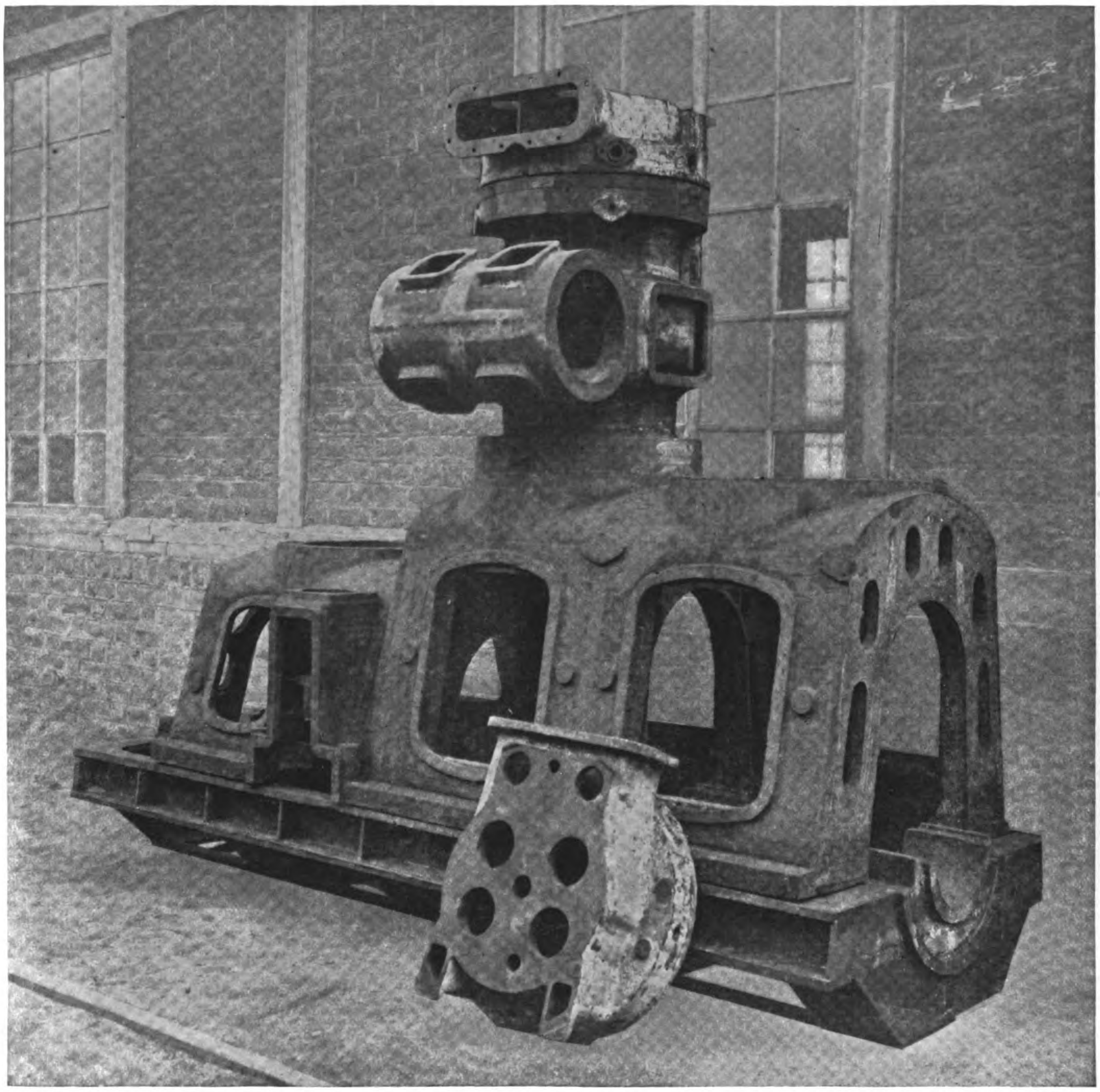
Cast steel bed-plate and crank-case frames for Schneider Naval-type Diesel engines

marine, profits by the combined view, such as is seldom obtainable by a builder of machinery not direct-connected with a shipbuilding yard. So he is enabled to combine the finest of machinery and hulls and obtain the best results.

Messrs. Schneider & Cie, the great French Shipbuilders and Engineers, can lay claim to this title, filling such a privileged position, which has enabled them to make extensive improvements in building submarines and at the same time Diesel motors.

The co-operation of their naval shipbuilding yards with their engineering workshops could not fail to bring about very much better results than if they depended solely on their metallurgical organization. Their experience and the exceptional means of production and experimenting allowed them to study and to ascertain the metals best adapted for heavy-oil engines designed for high rotary speeds.

In 1909, Messrs. Schneider & Cie decided to commence building submarines at their shipbuilding yards at Chalon-sur-Saône, France, already well-known by the many torpedo-boats and destroyers that they had constructed and delivered to various navies. At the same time, they began, in their great engineering works at Le Creusot, the study and construction of Diesel motors for submarines. This



Steel and Iron Castings for a Diesel engine made at one of the Schneider foundries

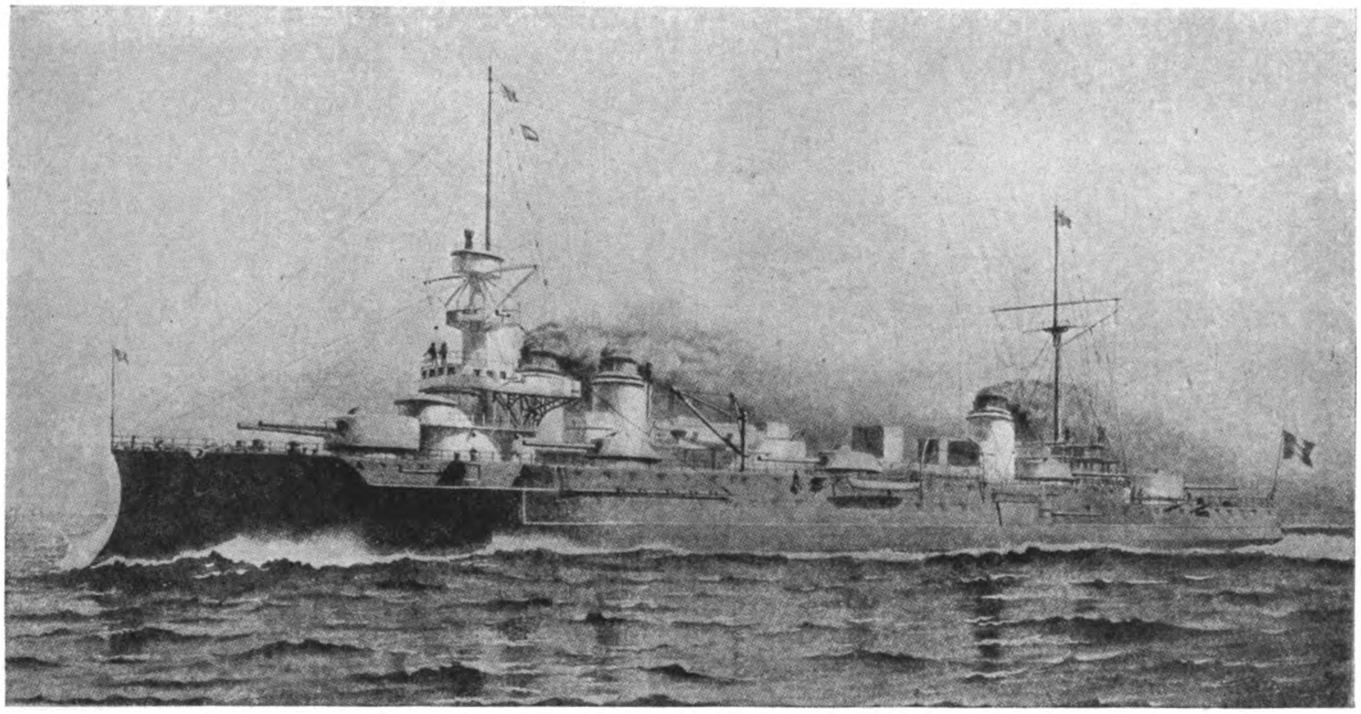
plant was already skilled in constructing steam-engines, both reliable and powerful, for the Navy. Just previously they had built a succession of engines for large torpedo-boats for the French navy, also those of the armored vessel "Verité" and of the armored cruiser "Edgar-Quinet."

These workshops at Le Creusot were properly equipped, particularly the testing shop which was provided with brakes, testing dynamos, etc. Their excellent

facilities led to building eight Diesel motors of 360 B.H.P. at 400 R.P.M., which were installed in four C-class submarines of about 300 tons on the surface and of about 450 tons submerged displacement. These vessels were delivered, two to the Peruvian and two to the Greek navy.

Their engines were of the four-cycle type, with cylinders 300 mm. bore by 280 mm. stroke. The results of the trials were extremely satisfactory; the speed attained on the surface for the four vessels was found to be between 12.796 knots and 13.213 knots.

These trials, like the succeeding ones, were made in the vicinity of Toulon, the French Naval port, where Schneider & Cie built a special trial-station with workshops, store-house, etc.



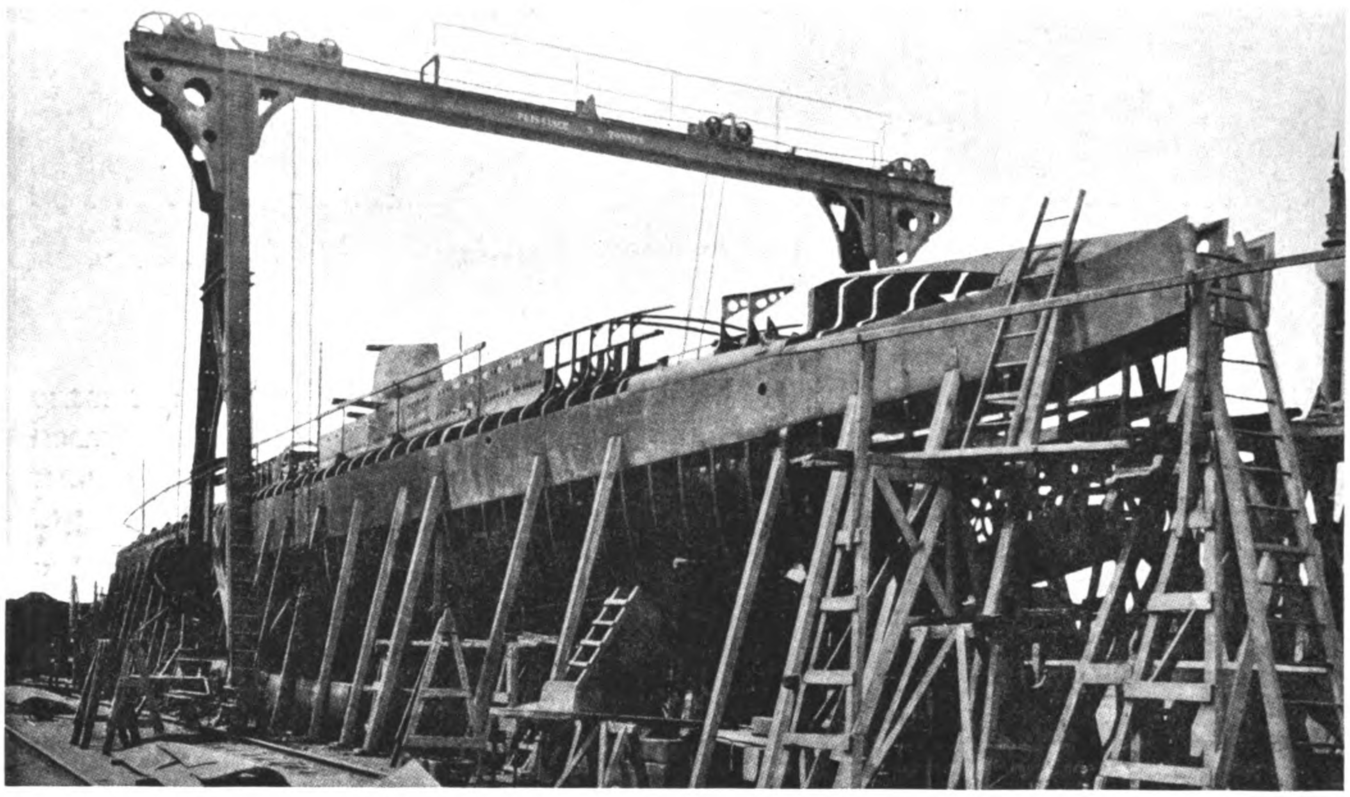
The Warship "Verité" Built by Schneider & Cie at Bordeaux for the French Navy

It is to be noted, by the way, that the highest speed attained when submerged was between 8.18 knots and 8.315 knots, although the specification required only 8 knots. According to all reports these were very high figures for vessels of their displacement, which again demonstrates what has been mentioned above regarding the plan of combining the construction of the hull and engines.

The operation and reliability of the two Greek submarines were very noteworthy. The "Delphin" left Toulon on September 29th 1912, under the command of officers and a Greek crew without any of the representatives of the Schneider Company on board, nor a convoy, illustrating confidence of the Greek mechanics who knew nothing of this type of engine, they only having seen them during the tests at the workshop and on board. In spite of very bad weather the

"Delphin" reached Corinth on October 5th 1912, after 130 hours' continuous operation of the engines.

Following this first series of submarines, Messrs. Schneider & Cie undertook the building of four D-class submarines of much greater tonnage; namely, 460 tons on the surface and 665 tons submerged. These vessels were provided with two motors of 1,100 B.H.P., each for surface propulsion. These engines were of the two-cycle type with eight cylinders of 13.8" stroke by 12.6" bore, and weighed, including clutch, water, and oil, 23,720 kilos, or 46 lbs. per H.P. We may mention, by the way, that the electric equipment of these vessels, including the electric-motors used for propelling while submerged, and the greater part of



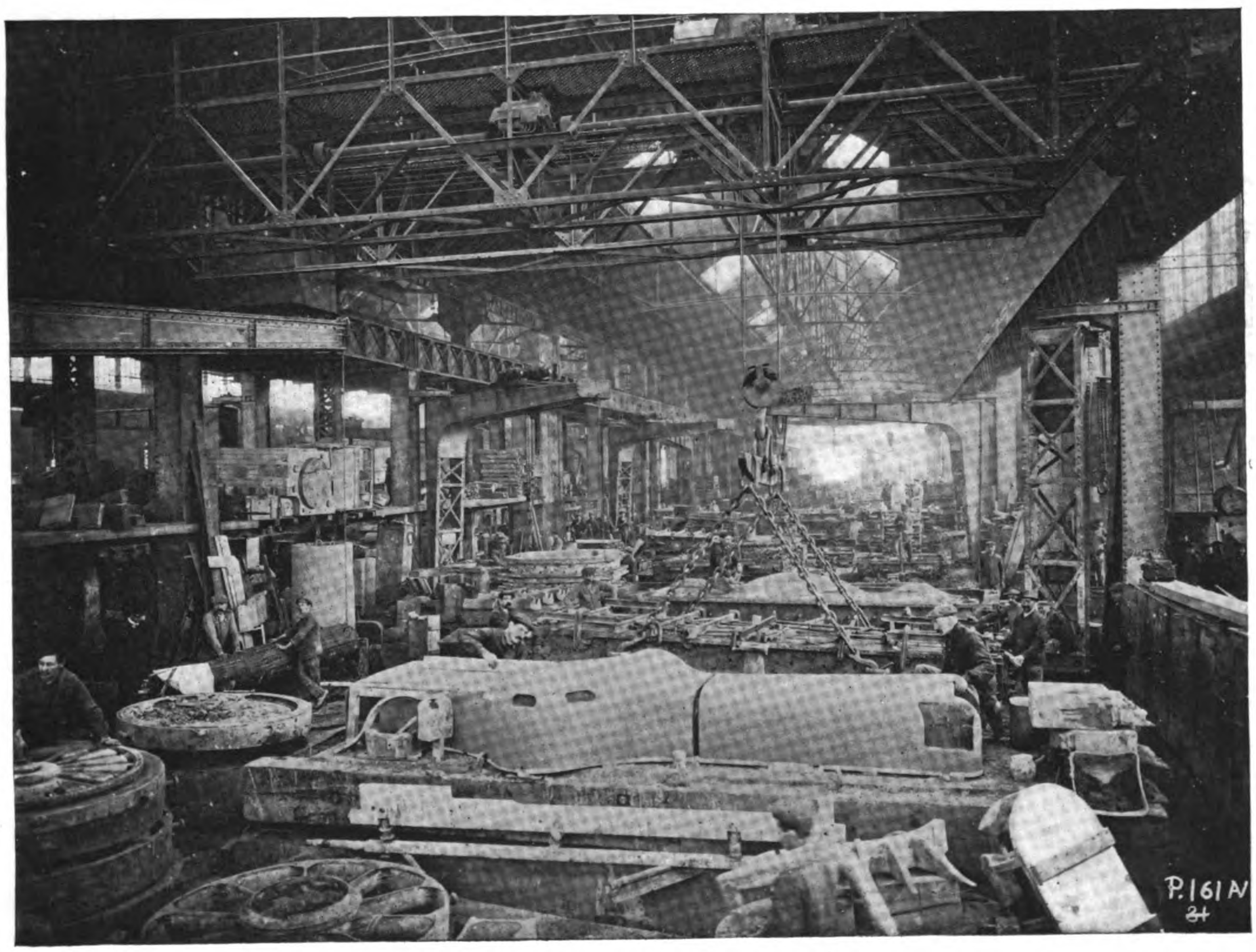
A submarine under construction at Messrs Schneider & Cie's Chalon-sur-Saône shipyards

the auxiliary apparatus, was designed and built by Messrs. Schneider & Cie in their electric workshops at Champagne-sur-Seine.

The results were quite noteworthy, and of the four submarines commenced, two were intended for the Imperial Japanese Navy, and two for the Greek Navy. But the war broke out before their completion, so three of them were requisitioned by the French Navy and only one was delivered to Japan.

Of the three vessels which were tested by the French Navy, the contract speed of 17 knots on the surface and 10.5 knots submerged, was greatly exceeded; the speed attained was 17.46 knots, 17.37 knots and 17.52 knots, on the surface and 10.59 knots, 11.25 knots and 11.32 knots submerged, respectively.

A Pattern-shop at Le Creusot works



Part of the Foundry at Le Creusot works

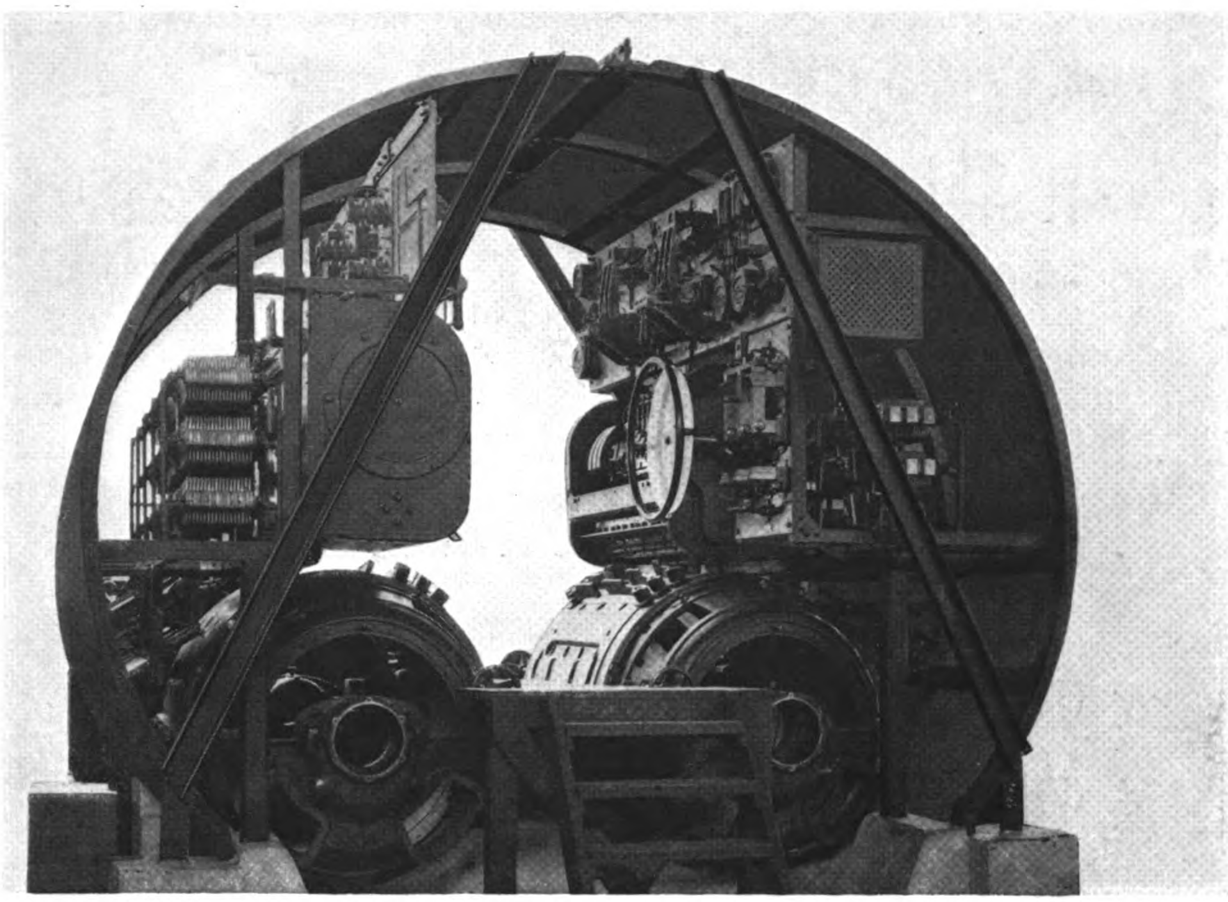
Women tracers at work at Le Creusot

In regard to the operation of these engines it was demonstrated during the first trial-trip of one of these vessels, between Bordeaux and Toulon, that she could enter the Port of Gilbraltar and be moored to her buoy working only with her heavy oil engines. The reversing from ahead to astern was carried out in less than 10 seconds with but a trifling loss of compressed-air, and without de-clutching the propellers.

One of the many drafting-rooms belonging to the Schneider Establishments

All these points made the D-Class submarines, notwithstanding their small tonnage, vessels that could rival in every respect the speed of submarines of 600 to 700 tons surface-displacement. Their armament of two interior torpedo-tubes of 450 mm diameter with two reserve torpedos, and two water-tight exterior tubes, also a gun on deck added to their value as vessels of war. It can therefore be stated that Messrs. Schneider & Cie have once more demonstrated the good results of unity of purpose and execution in the building of a vessel.

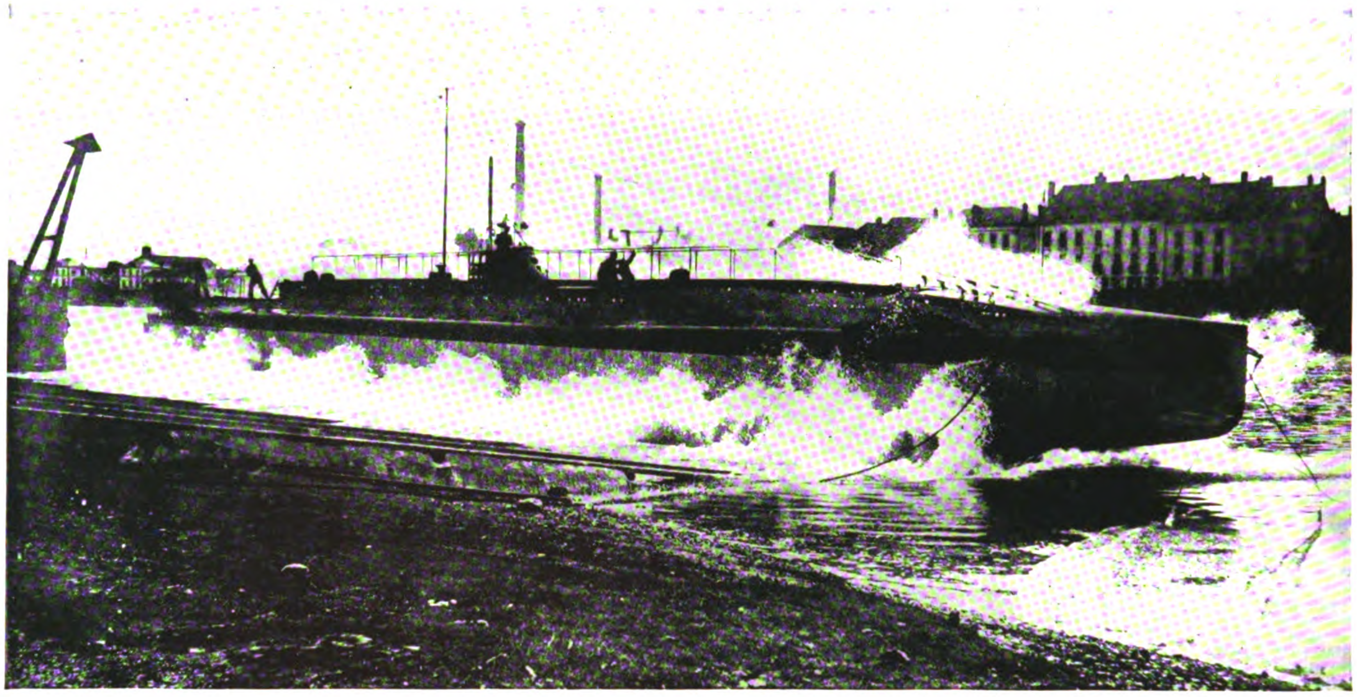
At the present time, Messrs. Schneider & Cie have in process of construction a number of smaller submarines, of the coastwise class, and a submarine of 1000



(D-class submarine) Assembly of Electric Motor Compartment in the Shop

tons for the French Navy. Besides the engines intended for the submarines built in their yards, Messrs. Schneider & Cie have furnished a number of engines for the submarines built by the French Navy Department in their dockyards. Among these, together with several experimental motors, we will mention a series of six two-cycle type Diesel engines that have six cylinders developing 650 B.H.P. at 400 R.P.M. and a series of six two-cycle Diesel engines that have eight cylinders developing 1450 B.H.P. at 330 R.P.M.

One of the engines of this latter class has maintained interruptedly a test of 140 hours when averaging 1160 B.H.P. A submarine fitted with two motors of this power accomplished in 15 days a series of official tests as follows:



Launching a Diesel-engined Laubeuf-type submarine at one of the Schneider shipyards

(A) Official test of four hours at maximum power.

(B) Test of 24 hours at 8/10th of maximum power.

(C) Final fuel consumption test on surface of both engines at 13 knots.

(D) Final fuel consumption test on surface with one engine.

(E) Final test of consumption and speed with submarine partly submerged.

(F) Test of charging the battery while under way and while stationary.

APPLICATION OF THE DIESEL ENGINE TO MERCANTILE VESSELS

AS shown at the beginning of these notes, the internal-combustion engines for the submarine present, by reason of the rigorous requirements to which they must respond, very minute difficulties in design and construction.

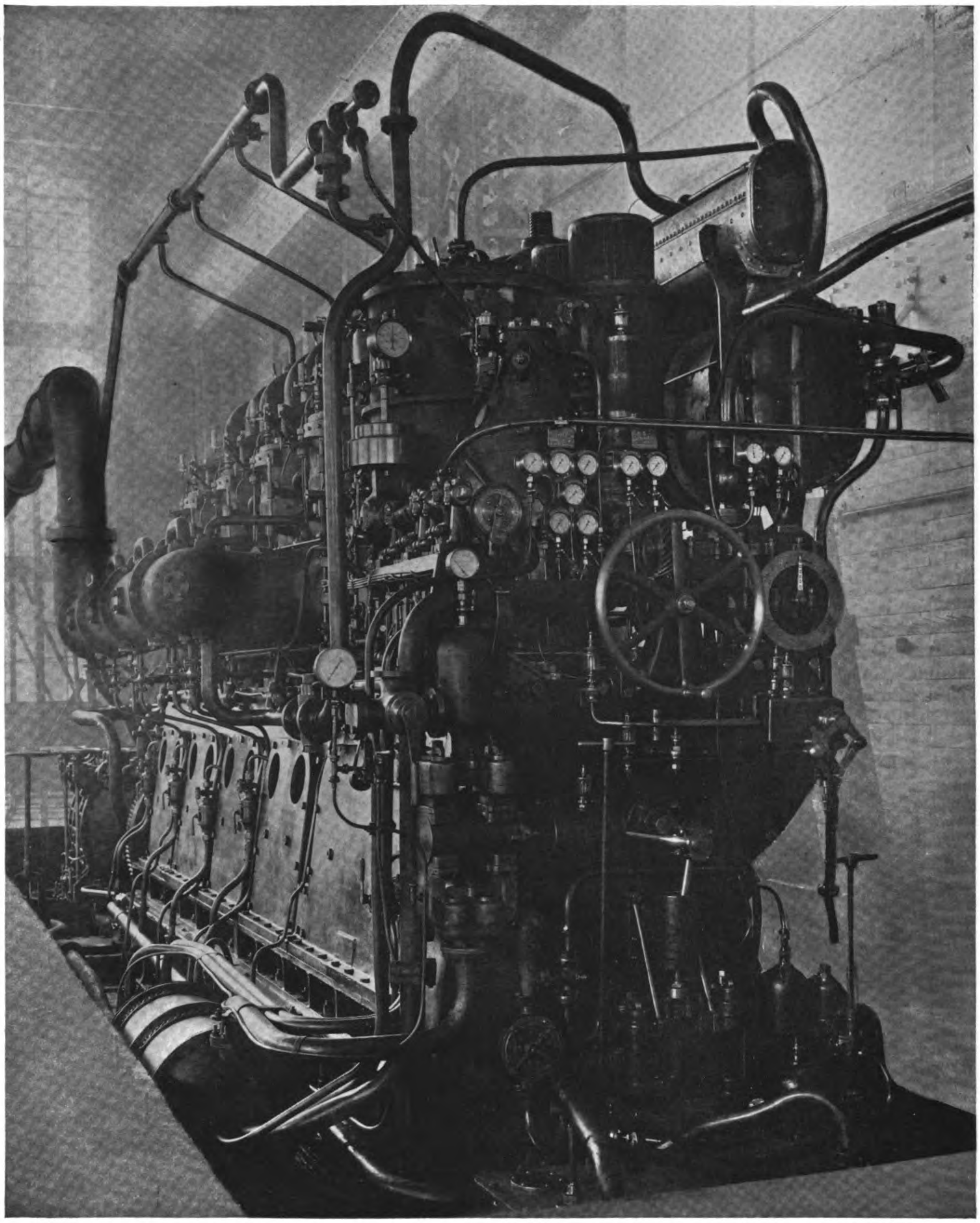
Motors for propelling cargo and other mercantile vessels—of which the weight per horse-power is about half way between that of stationary engine and submarine motors,—are constructed much easier. Messrs. Schneider & Cie, admirably equipped, owing to their experiences with submarines, started early in 1912 to build Diesel engines for merchant-ships.

The first attempt was made on the large steel sailing-ship "France" with auxiliary motors of high power, the dimensions of which vessel are as follows:—

Displacement	10,730 tons
Dead-weight-capacity	8,100 tons
Net-cargo capacity of holds	7,500 tons
Cubic-capacity of holds	430,000 cubic-feet
Cruising radius	20,000 nautical-miles
Length	430 feet
Breadth	56 feet
Depth	28½ feet
Loaded draught	24 feet

The 10,730 tons displacement Schneider built and engined Diesel-driven auxiliary sailing-ship "France"

This vessel, a five-masted barque, was built by the Société des Chantiers de la Gironde, of Bordeaux, with whom Messrs. Schneider & Cie are intimately connected, and where were built the "Verite" and other large warships. She is equipped with two direct-reversible Diesel motors of 900 B.H.P., each at 230 R.P.M. The reason of the adoption of this internal-combustion engine was the desire that the engine-room should encroach as little as possible on the space set aside for cargo. Each motor is of the two-cycle type with 4 cylinders 17.779 ins. bore by 22.047 ins. stroke. Their weight, including water and fuel-oil, works out at 114 lbs. per brake-horse-power.



One of the two 900 b.h.p. Diesel engines of the auxiliary sailing-ship "France"

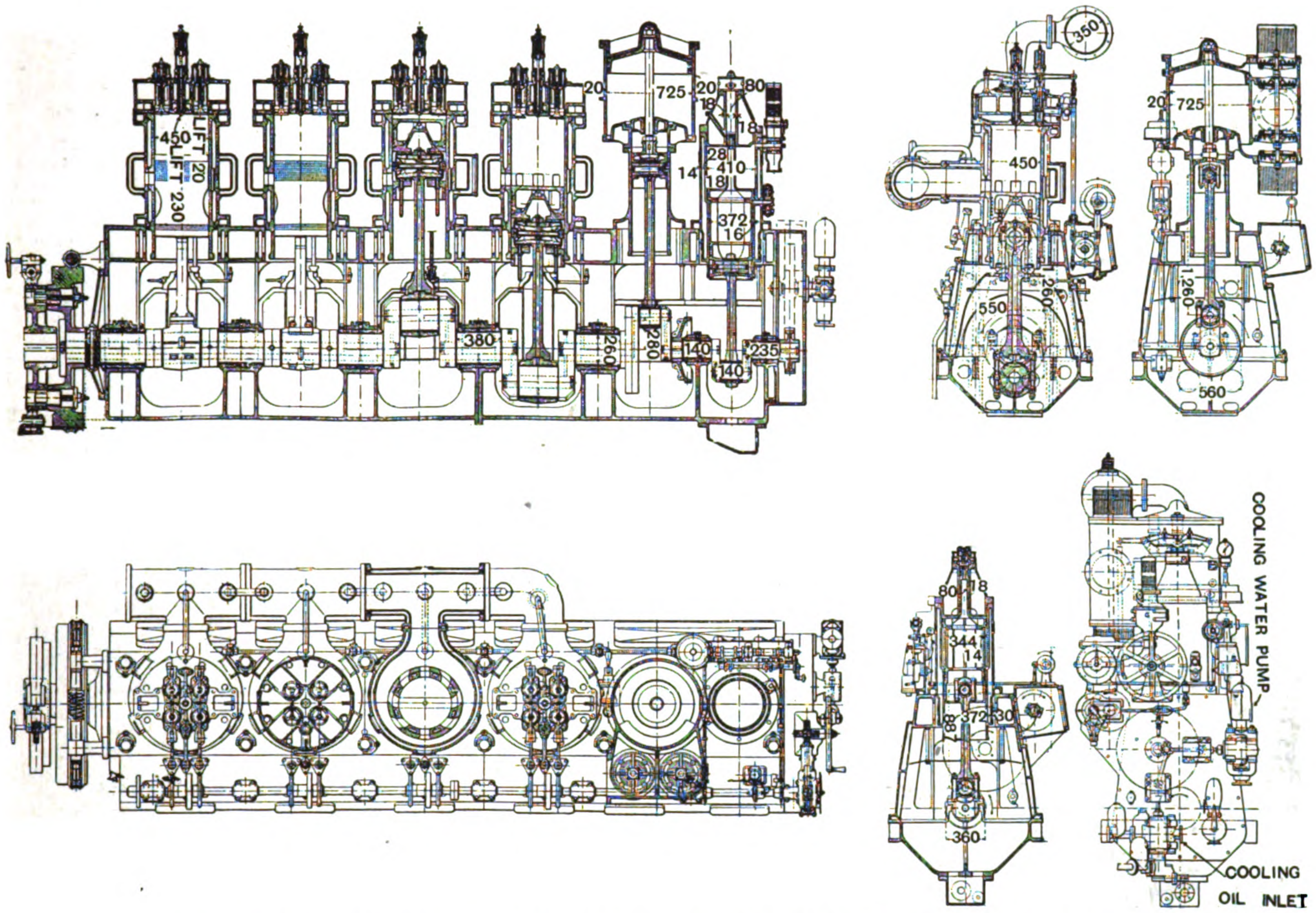
Notwithstanding, their fairly light weight, the motors exhibited excellent durability powers and in service have made non-stop runs of 22 and 16 days at 7 to 8 knots speed without sails. They also were tested-out as follows:

In the course of the first trial trip, from la Pallice to Glasgow, which had to be abandoned before completion in consequence of a storm, the motors operated without incident.

On the other hand, during the maiden voyage of the vessel from Glasgow, the motors worked a total number of hours, as follows:

Port motor	. . . .	635 hrs. 35 mins. (or 26 days, 11 hrs. 35 mins.)
Starboard motor	. .	654 hrs. 10 mins. (27 days, 6 hrs. 10 mins.)

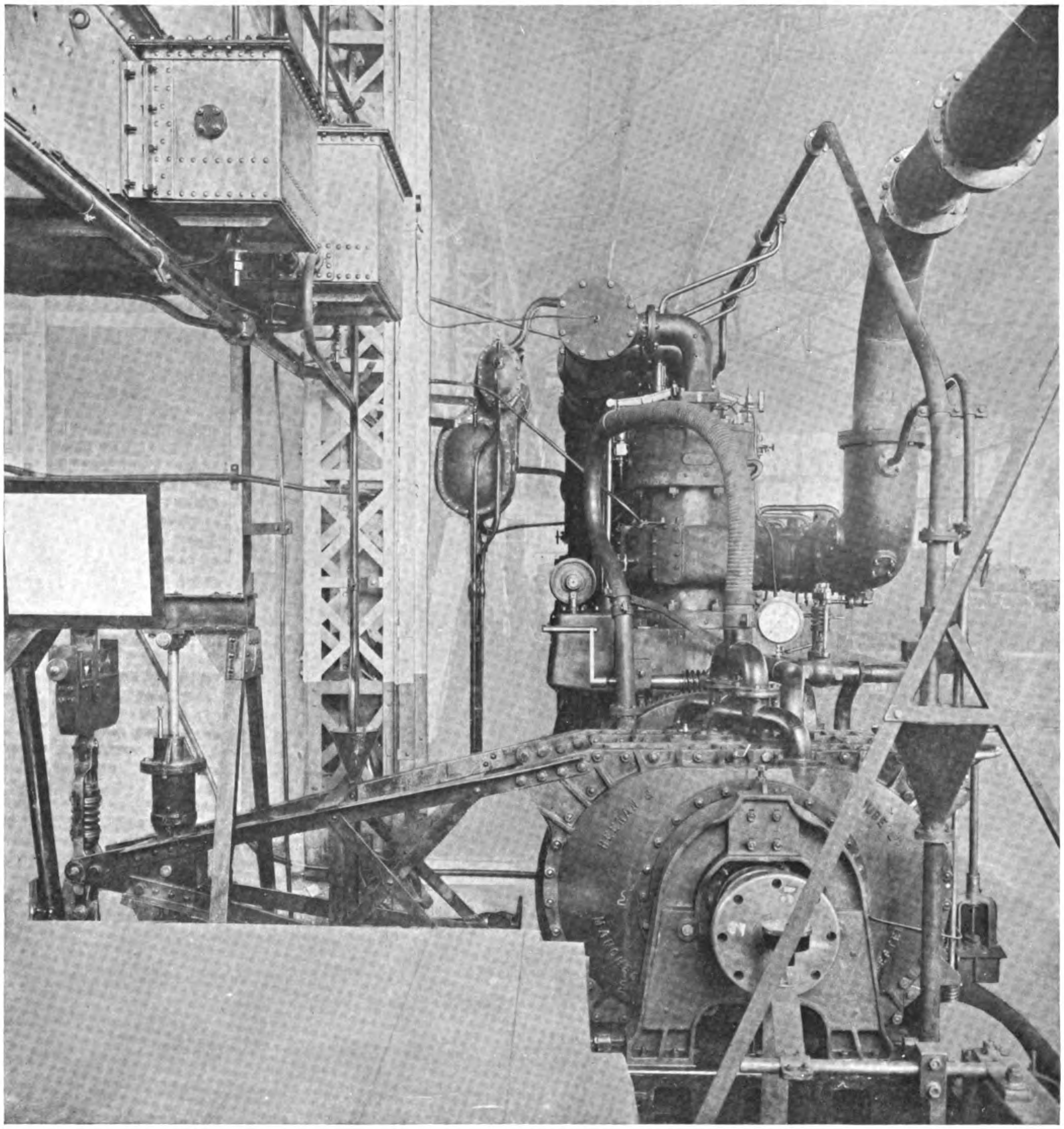
with perfect satisfaction.



Sectional drawings of one of the 900 b.h.p. (1,300 I. H. P.) Diesel engines built by Messrs. Schneider & Cie for the auxiliary ship "France"

After the first 4¾ years the cylinders were measured and the maximum wear was but 2/10 mm. in the center of the walls. The wear of the main bearings has averaged only 2/10 mm. per 100 days operation and the original white-metal is still in place. No crank-shaft fracture or crack ever has occurred, although they are one-piece forgings. The weight of the entire machinery of the "France," including propellers, shafting, clutches, and all engine-room auxiliaries, but not including the deck boilers, is 130 tons. Yet the two engines together developed 2610 I.H.P. (1,848 shaft H.P.) on the test-bed. Their overall length is 22 feet, including the clutch.

As regards manipulation, one can judge of this when the difficulty of entering a port like Greenock is considered. Delicate manoeuvering of the ship was accomplished without incident, with the sole aid of the motors, and without the assistance of tugs.



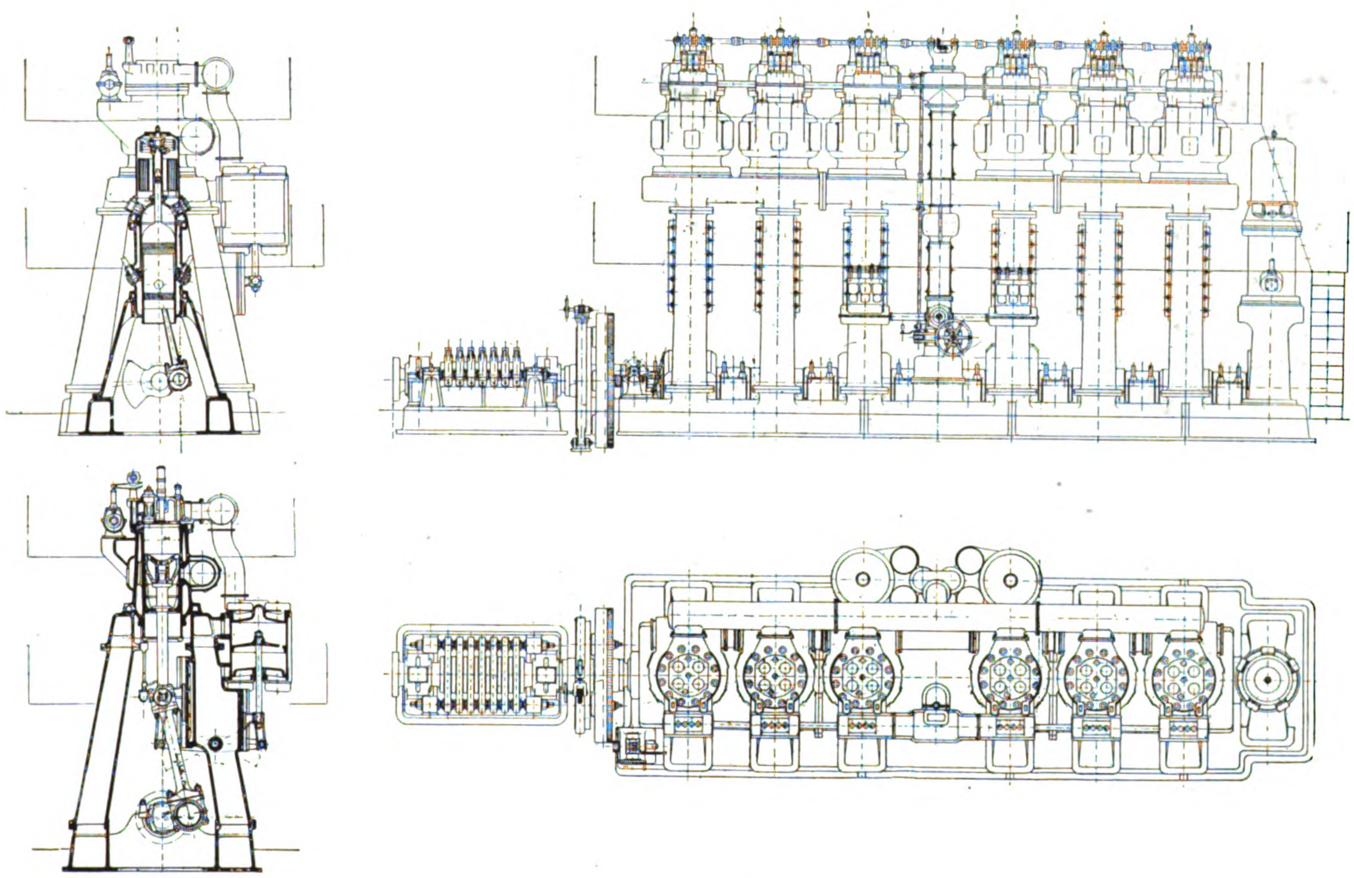
Schneider 900 b.h.p. cargo-ship Diesel engine being tested by means of a Heenan & Froude dynamometer
Note the efficient fuel-consumption measuring devices

During the six-and-a-half years this vessel has been in service the fuel generally used has been Mazout crude oil of 0.930 gravity, and sometimes African Peanut oil, but her Chief-Engineer, Mathurin-Calves, says he does not mind what

sort of crude-oil he picks up as it all burns without trouble. At full power, the consumption is 6 tons (i.e. 42 barrels) per 24-hour day.

The following is the results of a full-power shop test of one of the "France's" two direct-reversible Schneider two-cycle type Diesel engines:

Revolutions per minute	234
Mean-indicated pressure	7.04 kg. per c/m.2 (100.5 lbs. per sq. in.)
Corresponding indicated-power	1305 I. H. P.
Brake horse-power	924 h. p.
Efficiency of the motor	70.7%
Consumption of fuel per i. h. p. hour	0.148 kilos (0.32 lbs.)
Consumption of fuel per b. h. p. hour	0.208 kilos (0.46 lbs.)
Consumption of lubrication-oil per b. h. p. hour	5.3 grammes
Pressure of oil for lubrication	5 lbs. per sq. in.
Pressure of oil for piston circulation	2.5 atm. (35.6 lbs. per sq. in.)
Pressure of water	1.25 atm. (17.8 lbs. per sq. in.)
Scavenging-air pressure	56 atm. (800 lbs. per sq. in.)
Injection-air pressure	56 atm. (800 lbs. per sq. in.)
Lubrication temperature	Before cooling 37 deg. C. After cooling 29 deg. C.
Temperature of piston oil	Before cooling 96 deg. C. After cooling 68 deg. C.
Temperature of circulating water	Inlet 8 deg. C. Outlet 37 deg. C.



General arrangement of the Schneider 1800 b.h.p. merchant-marine Diesel engine

The war which compelled Messrs. Schneider & Cie to devote all their efforts to the production of war materials, put a temporary stop to the building of heavy-oil motors for cargo-vessels in their workshops. However, they recently resumed this branch of their industry, but have transferred the same from Le Creusot to their plant at Harfleur, near Le Havre, in a greatly enlarged capacity. These workshops, which turned out, during the war, a large share of the artillery material for the Allies, have had extensive practice in precision tools and instruments. They are, therefore, well equipped for turning out the delicate parts of Diesel engines.

The building of the following motors is being arranged and the designers have taken into consideration the information collected in regard to the Diesel motors already in use, the majority of which are installed in the submarines that have undergone the tests of long periods of operation in war service.

Series 1. High-Speed Motors

Motors of the 4-cycle type of 350 and 500 B.H.P. with 8 cylinders.

Motors of the 2-cycle type of:

600 B.H.P. having 4 cylinders specially for electric-transmission, and for electric power stations on land.

600 B.H.P. with 6 cylinders.

1000 and 1500 B.H.P. with 8 cylinders.

Series 2. Heavy-Duty Engines

Two-cycle Diesel engines of 1500 to 1800 H.P. with 6 and 8 cylinders for cargo vessels.

The foregoing will be sufficient demonstration to indicate that Messrs. Schneider & Cie will obtain very considerable success with the high-powered, slow speed, Diesel engines for merchant ships now under construction at the Harfleur works.